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Y-12 Groundwater Protection Program
Monitoring Well Inspection and Maintenance Plan

Revision 3

December 2006

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Acronyms

AJHA	Automated Job Hazard Analysis
BCV	Bear Creek Valley
BJC	Bechtel Jacobs LLC
CERCLA	Comprehensive Environmental Response, Liability, and Compensation Act
CY	calendar year
DOE	U.S. Department of Energy
GIMS	Groundwater Information Management System
GWPP	Y-12 Groundwater Protection Program
LLC	Low Clearance Cap
MOP	Monitoring Optimization Plan
P	Primary Inspection item
P&A	plugging and abandonment
PVC	polyvinyl chloride
RCRA	Resource Conservation and Recovery Act
S	Secondary Inspection item
SS	stainless steel
TOC	top of well casing
TOWW	top of Well Wizard®
WI&M	Well Inspection and Maintenance
WMR	Well Maintenance Request
WW	Well Wizard® Bladder pump – dedicated
Y-12	Y-12 National Security Complex

1.0 INTRODUCTION

This document is the third revision of the *Monitoring Well Inspection and Maintenance Plan* for groundwater wells associated with the U.S. Department of Energy (DOE) Y-12 National Security Complex (Y-12) in Oak Ridge, Tennessee (Appendix A, Fig. 1). This plan describes the systematic approach for:

- inspecting the physical condition of monitoring wells at Y-12,
- identifying maintenance needs that extend the life of the well and assure well-head protection is in place, and
- identifying wells that no longer meet acceptable monitoring-well design or well construction standards and require plugging and abandonment.

The inspection and maintenance of groundwater monitoring wells is one of the primary management strategies of the *Y-12 Groundwater Protection Program* (GWPP) *Management Plan*, "proactive stewardship of the extensive monitoring well network at Y-12" (BWXT 2004a). Effective stewardship, and a program of routine inspections of the physical condition of each monitoring well, ensures that representative water-quality monitoring and hydrologic data are able to be obtained from the well network. In accordance with *the Y-12 GWPP Monitoring Optimization Plan* (MOP) *for Groundwater Monitoring Wells at the Y-12 National Security Complex, Oak Ridge, Tennessee* (BWXT 2006b), the status designation (active or inactive) for each well determines the scope and extent of well inspections and maintenance activities (see Section 3.0). This plan, in conjunction with the above document, formalizes the GWPP approach to focus available resources on monitoring wells which provide the most useful data.

This plan applies to groundwater monitoring wells associated with Y-12 and related waste management facilities located within the three hydrogeologic regimes (Appendix A, Fig. 2):

(1) the Bear Creek Hydrogeologic Regime (Bear Creek Regime),
(2) the Upper East Fork Poplar Creek Hydrogeologic Regime (East Fork Regime), and
(3) the Chestnut Ridge Hydrogeologic Regime (Chestnut Ridge Regime).

The Bear Creek Regime encompasses a section of the Bear Creek Valley (BCV) immediately west of Y-12. The East Fork Regime encompasses most of the Y-12 process, operations, and support facilities in BCV east of Scarboro Road. The Chestnut Ridge Regime is directly south of Y-12 and encompasses a section of Chestnut Ridge that is bound to the west by a surface drainage feature (Dunaway Branch) and by Scarboro Road to the east. The GWPP maintains an extensive database of construction details and related information for the monitoring wells in each hydrogeologic regime in the *Updated Subsurface Database for Bear Creek Valley, Chestnut Ridge, and parts of Bethel Valley on the U.S. DOE Oak Ridge Reservation* (BWXT 2003a). A detailed description of the hydrogeologic framework at Y-12 can be found in the GWPP Management Plan (BWXT 2004a).

2.0 BACKGROUND

A regular program of well inspection and maintenance (WI&M) was instituted by the GWPP after a 1989 DOE Tiger Team finding of non-compliance with U.S. Environmental Protection Agency guidance regarding well security and well access. After the initial finding, and upon further investigation, the following items were self-identified and documented for the existing well network at that time: well security, well access, well identification, and maintenance. A program of routine surveillances (i.e. well inspections) was initiated as a corrective action to the finding to survey and document (i.e. checklists) the above items. Well maintenance requests were compiled from these surveillances and the maintenance work submitted to the drilling contractor for repairs. All maintenance work performed was inspected and documented.

The WI&M program was first outlined and formalized in *Monitoring Well Inspection and Maintenance Plan for the Department of Energy Y-12 Plant, Oak Ridge, Tennessee* (MMES 1991). This plan:

- outlined a program for routine inspection of the physical condition of each monitoring well at Y-12,
- identified well components to be inspected,
- defined minimum acceptable standards for each component,
- established a well maintenance program, and
- established procedures for performing and documenting well inspections and maintenance performed.

Procedures (G-001 and G-002) detailing the step-by-step process of well inspections and depth measurements were first published with this plan. The 1991 plan required only that the Monitoring Well Inspection/Maintenance Summary be updated and reissued each year. The first revision of this plan (Y/TS-1215, July 1994) clarified the definition of active wells and updated the two procedures (G-001 and G-002). The second revision of this plan (LMES 1996) instituted a new mechanism to track the status designation of a monitoring well. The second revision was prompted by the rapid growth of the monitoring well network during the mid-1990s and the changing regulatory requirements resulting in constant changes to the status designation of each well.

This document is the third revision of the WI&M Plan and this plan incorporates the language and structure of the GWPP Monitoring Optimization Plan (BWXT 2006b) to aide in determining the scope and extent of well inspections and maintenance activities (Section 3.1 and 3.2). This revision also removes the monitoring well construction summary, procedures G-001 and G-002, and the personnel training certification forms (see discussion in Section 3.2 for all of the above).

As of this publication, GWPP's Groundwater Information Management System (GIMS) indicates there are 1360 groundwater monitoring wells, boreholes, borings, and coreholes that have been installed or drilled at Y-12. These wells or borings were installed to meet various groundwater quality monitoring programs, research projects, remedial investigations, plume characterization and delineation studies, and various hydrogeologic interest. Of these, 581 have been plugged and abandoned, destroyed, could not locate, or the status is unknown. Of the 779 remaining wells, a total of 550 have been assigned a status designation of either active or inactive status in accordance with the MOP and will be the focus of the WI&M program. For the remainder, 229 wells or borings, this plan does not apply to and are either considered 1) not to be in service and will be scheduled for plugging and abandonment in the future, or 2) are temporary piezometers or other specialized groundwater monitoring devices that were previously installed for research purposes, hydrologic testing, pilot studies, or short term investigations.

3.0 TECHNICAL APPROACH

The technical approach of this plan involves:

- determining the status designation of the well (e.g., determines the inspection frequency— annual or triennial basis),
- establishing a program of routine well inspections to assess the physical condition of each well,
- identifying maintenance needs from the well inspections,
- prioritizing maintenance work based upon well status, well component, and available resources,
- documenting and verifying all maintenance work that is performed, and
- identifying wells that no longer meet GWPP technical specification, or are damaged beyond repair, and must be plugged and abandoned.

A step-by-step flow diagram (Appendix A, Fig. 3) illustrates the GWPP's Well Inspection and Maintenance Program in detail.

The objectives of the plan are to:

- describe the well status designation,
- establish the current business practices of the GWPP Well Inspection and Maintenance program,
- describe the role and duties of the Well Inspection and Maintenance Coordinator
- identify and describe the well components (inspection items),
- define the minimum acceptable standards for the condition of each well component,
- establish the maintenance program to correct well components that do not meet these standards,
- describe how well inspection and maintenance activities are prioritized, managed, and documented, and
- describe the final publication of each calendar year's inspection and maintenance activities.

3.1 WELL STATUS DESIGNATION

The GWPP Monitoring Optimization Plan (MOP), first issued in 2003, formalized the technical approach the GWPP took to focus available resources on monitoring wells at Y-12 that provide the most useful hydrologic and water-quality monitoring data (BWXT 2006b). The MOP formalized the definition of "active" and "inactive" status, outlined the process for determining a well's status designation, provided comprehensive lists of wells (approved by the GWPP manager) that were granted either active or inactive status, and formalized how changes (additions, deletions, change in status designation) were documented (i.e. addenda).

The status designation (active or inactive) of a well determines the frequency of well inspection, the scope of the inspections, and the prioritization of maintenance. This WI&M plan formally adopts the status designation of each well assigned in the MOP and focuses resources only on those well locations. This designation differs from past WI&M

plans where all existing wells, boreholes, coreholes, and borings were included in the WI&M program.

The criteria for determining a well's status designation are briefly summarized below.

Active status is granted to wells:

- under a regulatory program (Section 3.2),
- wells sampled specifically to address applicable groundwater monitoring requirements in DOE Order 450.1,
- wells used to monitor groundwater surface elevations (refer to as hydrological monitoring),
- wells known to yield contaminated groundwater, and
- wells located hydraulically down-gradient of a Y-12 facility, or a known source of contamination, that provide unique hydrologic or water-quality information (BWXT 2006b).

Changes to the status designation of a well are done with approval of the GWPP manager and are documented in an addendum to the MOP. Active status will also be granted to any newly installed well that meets GWPP's design and construction standards, serves an ongoing regulatory program, and/or the programmatic needs of the GWPP. The status of the well may change if the well no longer meets any of the above conditions; the well has been damaged beyond repair, or at the discretion of the GWPP manager (BWXT 2006b).

Inactive status is granted to wells where:

- the design and construction details are unknown,
- the wells do not meet technical standards of the GWPP or other requirements (e.g. all weather access),
- monitoring data are not available
- wells are not located hydraulically down-gradient of any facility associated with Y-12 or any source of contamination
- wells monitor uncontaminated groundwater, and provide redundant monitoring coverage (BWXT 2006b).

The status of a well may change from inactive to active if (1) one of the above conditions changes and/or (2) at the discretion of the GWPP manager. A well is removed from the active or inactive list if the well is damaged beyond repair and an official plugging and abandonment (P&A) request has been submitted.

There are two well inspection schedules for monitoring wells listed in the MOP. With the exception of inspecting down-hole conditions (i.e. well depth measurements), active wells are inspected on an annual basis ("Annual Inspection Checklist", Appendix B) for both the primary (P) and secondary (S) inspection items (see discussion in Sections 3.2 and 3.3). Both the active and inactive wells are inspected on a triennial basis ("Triennial Inspection Checklist", Appendix B) and down-hole conditions are assessed at that time. This differs from previous WI&M plans where the down-hole conditions where evaluated every year. In 2003, a review of the depth measurements revealed that there was little, if any, substantial change in the measured depths at each well observed over multiple years, unless sedimentation was an obvious problem (Section 3.3.3). Maintenance on active wells is prioritized based on resources and need. Emphasis is placed on maintaining primary inspection items on all wells. Inactive wells are inspected for primary and secondary inspections items, but only primary inspection items are given priority (Section 3.2).

3.2 WELL INSPECTION AND MAINTENANCE PROGRAM

For each calendar year (CY) inspection event, the WI&M coordinator compiles the list of wells from the MOP, includes/excludes wells added or removed from the MOP (addenda), and excludes all wells managed under "other programs" (active wells listed under "Regulatory Monitoring Programs" in the MOP). Currently, the Environmental Management contractor to DOE (Bechtel Jacobs LLC [BJC]), has the responsibility for performing regulatory monitoring for the 1) Resource Conservation and Recovery Act (RCRA) post-closure permits, 2) Comprehensive Environmental Response, Liability, and Compensation Act (CERCLA) Remedial Effectiveness and Records of Decision, 3) the five Solid Waste Disposal Facility permits, and 4) the CERCLA Environmental Management and Waste Management Facility. BJC has the responsibility for actively performing well inspections and maintenance on these wells.

The WI&M coordinator continues to compile the list of wells from the MOP and will:

1. remove any wells that have persistent, unsafe access problems, or are slated for plugging and abandonment, but have not been remove from the MOP,
2. compile well-specific information from the Subsurface Database (BWXT 2003a) or past inspections for wells that have obstructions, dedicated pumps (have to be pulled to get a depth measurement), off-normal well-head configurations (pressure relief valves—no depth measurements), dedicated packers (no depth measurements), or flush mount configurations,
3. give special instructions for known and/or posted well access requirements (off-road access, remote location, construction areas, active landfill operations, radiological work permits, bar-gated and fenced areas, contact number for entry, and keys needed for access).

The WI&M coordinator groups the wells by geographic location and by controlled access to Y-12 areas, and then provides field personnel work packages assigned by group number. Each work package contains the list of wells to inspect, the well inspection number (the first two digits designate the CY, followed by a unique three digit number), the length of the screened or open interval of the well, the reference tag depth (see discussion in Section 3.3.3), special instruction (discussed above), and copies of well location maps from the most recent Subsurface Database (BWXT 2003a).

Field personnel are trained in accordance with BWXT procedure Y71-66-EC-214, *Monitoring Well Inspection and Depth Measurement* (BWXT 2001). This procedure replaces GWPP's procedures G-001 and G-002 for well inspection and depth measurements. Procedure Y71-66-EC-214 is a controlled BWXT Y12 management requirement (i.e. document) that has a formal process for updates, changes, validation, verification and approval. Training is performed on an annual basis and qualifications are tracked and documented in Y-12 SAP business management database. The WI&M

coordinator is responsible for assuring that all field personnel are qualified and have been briefed on the hazards and controls the associate with the task to be performed. Field personnel are required to review and sign the associated Automated Job Hazard Analysis (AJHA) prior to starting any work.

Prior to performing well inspections, field personnel review group packages, all field information, and special instructions. Personnel gather appropriate equipment (weighted tape measures or taglines, bargate keys, plastic sheeting, plastic bags, and cleaning supplies), obtain a vehicle (4-wheel drive, if required), and make arrangements for access (posted conditions or contact numbers). When performing well inspections, field personnel verify the physical condition of each well location (note any new posted or access requirements), complete primary and secondary inspection items on the checklist (see Section 3.3), perform and record a depth measurement (if required), note whether dedicated monitoring equipment is present, note if the depth measurement was soft or hard, and note any other problems or anomalies (BWXT 2001). The well inspection checklists are signed and return to the WI&M coordinator. Field personnel discuss any abnormalities seen in the field and any items that require immediate attention.

The WI&M coordinator reviews the checklists for completeness and accuracy, and then compiles all inspection items that require maintenances. Maintenance items are prioritized according to well status, primary (P) or secondary (S) inspection items, and available resources. A Well Maintenance Request [(WMR), see Appendix C] is initiated indicating the type of maintenance requested (P or S) and a detailed description of the maintenance work needed. The WMR is the official record of GWPP maintenance activities, documenting the work requested, actual work performed, and noted exceptions. Each WMR is assigned a unique identifier, which is subsequently documented on the well inspection checklist that initiated the work. The WMR is issued to a service provider (service subcontractor or the Y-12 Maintenance Organization) to perform the maintenance work. The service provider performs a walk-down of the requested work, provides input, and provides a cost estimate. After an agreed upon scope of work and cost is arrived at, the maintenance work is performed by the service provider in accordance with the technical specifications outlined in the WMR, this plan (see Section 3.3), and/or in a specified statement of work. All maintenance work is inspected for completeness and any problems, comments, or deviations from the agreed upon scope of work is documented (where work cannot be completed as requested) on the WMR.

If the condition of a primary inspection item is beyond practical remediation or if the well is damaged beyond repair, the WI&M coordinator initiates a plugging and abandonment (P&A) request (Appendix C) and submits it to the GWPP manager for approval. The P&A request documents 1) the reason for P&A, 2) the licensed driller who performs the P&A, 3) date completed, and 4) all driller's and geologic oversight P&A documentation of the event (daily log sheets, diagrams). Each P&A request has a unique identifier. The well is removed from the active or inactive well list in the MOP once the P&A request is submitted and approved. Well inspection checklists, along with completed WMRs and P&A requests, are published in a triennial Well Inspection and Maintenance Report, as specified in Section 3.4.

3.3 WELL INSPECTION ITEMS (WELL COMPONENTS)

Active and inactive wells under the GWPP Well Inspection and Maintenance Program are inspected for both primary and secondary inspection items (Appendix B), each relating to a specific well component. Primary (P) inspection items are those well components that ensure representative subsurface conditions for sampling and hydrologic monitoring purposes. These components include the condition of the well casing, well security, well identification, and the down-hole condition of the screened or open interval. Because the primary inspection items are crucial to the well's integrity and the ability to collect representative data, these inspection items are given high priority for maintenance. Secondary (S) inspection items are those components of a monitoring well that if damaged or compromise will not generally affect the collection of representative groundwater quality samples or hydrologic information. These items include well access, concrete pad, and protective posts. For active wells, secondary inspection items will be maintained, but for inactive wells (unless there is a safety concern) maintenance of secondary items are performed on an as needed basis.

3.3.1 Well Casing (P)

Well casing diameter, material type, and construction have varied dramatically over the last 25 years of well installations at Y-12. Well casing type was often dependent upon the project/program installing the well, the driller, the well's depth, and the original purpose of the installation (hydrogeologic study, corehole, piezometer, water table well, bedrock well, or regulatory compliance well). In general, two types of monitoring wells are installed at Y-12: wells completed with screened intervals and wells completed with open-hole (open borehole below the cased section of the well) intervals.

Screened wells are used for monitoring groundwater in both unconsolidated and bedrock materials. Open-hole monitoring wells are used for only monitoring groundwater conditions in the bedrock zone. Most wells have a protective surface casing to hold the borehole open in the unconsolidated and weathered bedrock zones, while a smaller diameter riser casing is advance to a greater depth in the bedrock. Other types of drilled holes exists at Y-12 for the purposes of subsurface investigations, or sampling, include: coreholes, boreholes, drivepoint wells, piezometers (1-in. or less in diameter), and open borehole wells instrumented/installed with dedicated sampling devices (Section 3.3.2). The well-head configurations on these holes are similar to those described below.

For monitoring wells that have a screened interval, the well (riser) casing and screen are constructed of either stainless steel (SS) of polyvinyl chloride (PVC) material. Wells constructed of PVC require an outer protective surface casing (although not present for older generation PVC wells or small diameter drivepoints/piezometers), which encases the riser (PVC) casing above ground surface. This can be an extension of protective surface casing (mentioned above) extending above ground surface (Appendix A, Fig. 4), or an outer protective casing installed after the installation of the well (Appendix A, Fig. 4). The outer protective surface casing provides additional protection against vehicular damage (e.g. PVC riser casing is easily damaged), provides well security, and protects the PVC casing from degradation from direct sunlight. Wells constructed of SS normally do not require an outer protective surface casing (Appendix A, Fig. 5), but it was sometimes installed for 2-inch SS wells for additional protection. Bedrock wells with open-hole intervals are constructed with a steel well casing and are not completed with a protective surface casing (Appendix A, Fig. 7).

Riser casings and outer protective surface casings are inspected for signs of physical deterioration or damage, such as cracks, corrosion, breaks, dents, and bends that can affect the structural integrity of the well. Any well casing that has sustained vehicular damage should be noted on the checklist. Also, the exposed portion of the annular grout seal (see Appendix A, Figs. 4 and 5; cannot be seen on most wells) should be inspected for signs of deterioration (e.g., loose casing) or for cracks and breaks from wells that have had vehicular damage. For wells designed such that water can collect between the outer protective surface casing and the well casing itself, a weep-hole must be installed in the outer protective casing to allow the water to drain and prevent freezing.

Wells with a flush-mount design are employed in high traffic areas of Y-12 (Appendix A, Fig. 6). The riser casing is cut below ground surface, and the uppermost portion of the well casing is housed below grade inside a christy box or manhole, with a traffic cover that bolts down. In addition to standard inspection items, flush-mounted wells will be inspected for the following:

1) Is there a concrete apron around the christy box and is the box installed slightly elevated above grade with concrete sloping away from the well?
2) Is there a gasket seal for the traffic cover, and is it in good condition (does not leak)?
3) Is the traffic cover bolted to the christy box?
4) Does water collect inside the christy box? and
5) Is there a water-tight locking cap (sometimes called a “pipe plug”) present on the riser casing? Is it in good condition, and does it seal tightly to the casing?

Maintenance may involve replacing, extending the outer protective casing or the riser casing portion that is above ground; adding an outer protective casing around the riser casing; replacing/repairing the manhole/christy box for flush-mounted wells; adding grout in the annular space between the well casing and the outer protective casing; and repairing the annular grout near the ground surface (if casing is loose).

3.3.2 Well Security

To prevent unauthorized access, all monitoring wells at Y-12 are secured with stainless steel or brass locks. The type of well cap and locking configuration is based on the type and diameter of the riser casing, or the outer protective casing, and whether a dedicated bladder pump (Well Wizard®) or monitoring system (Westbay® Instrumentation or BarCad® units) is installed in the well. Wells with stainless steel casings have a stainless steel slip-on well caps that locks through a hasp welded to the cap and to the outside of the well casing (Appendix A, Fig. 8). PVC wells, with no outer protective casing, have a locking water-tight well cap (sometimes called “pipe plug”) with a slip-on PVC cap. For PVC casing with an outer protective casing (6-in.), an aluminum casing lid (some have a hinged stainless steel square casing with welded hasp) slips on over a hasp welded to the outside of the protective casing (Appendix A, Fig. 8). For steel casing wells (open-interval bedrock wells – 4-in., 7-in., or 10-in. in diameter), an aluminum slip-on collar bolts to the top of the casing and the manufactured lid slips over the collar (Appendix A, Fig. 8). There is a machined hole in the lid and a corresponding hole on the collar to lock the lid. This design is the same on all wells with a steel protective casing (usually 7-in. or 10-in. in diameter). For flush mounted wells (Appendix A, Fig. 7), a lockable water tight cap is required, independent of casing type or diameter.

Wells installed with dedicated Well Wizard® (WW) sample pumps have a different well cap and locking configuration (Appendix A, Figs. 9 and 10) than those listed above. The WW caps contain the connection fittings to operate the bladder pump; suspended by tubing below the cap. The different WW cap styles depend on the casing type, diameter, and the year the pumps were purchased and installed. Wells with dedicated WW pumps purchased in earlier years have a white PVC WW cap (Appendix A, Fig. 9): the base slips-on over the outer diameter of the casing, a gray plate contains the fittings and suspends the pump, and the top of the cap contains a locking pin that slip through the interior of the cap and locks the lid in place. The addition of these white PVC WW caps raise the measurement reference point from top of the well casing (TOC) to the top of the WW (TOWW) cap (Section 3.3.3.). Wells with dedicated WW pumps purchased in recent years have a low clearance cap (LCC), which rest on top of the well casing with the pump and tubing suspended below. These LCCs fit underneath the existing well caps (described above) and uses the existing well cap, hasp, and lock (Appendix A, Fig. 10).

Locks are inspected for corrosion and operation of the locking mechanism. All wells should have an assigned Y-series lock, each with a unique number (Y0-###). Hasps are visually inspected for corrosion, damage, and the overall condition of the welds. Hasps found to be substantially corroded will be replaced. Locks that are corroded or difficult to operate will be replaced; no lubricants will be used to improve performance of the lock mechanism because these substances may detrimentally impact water quality samples from the well. If a well shows evidence of tampering (i.e. bolt-cut locks or broken hasps), the inspection personnel will notify the WI&M coordinator for further action. Well caps are inspected for snugness to the casing, should not be able to remove cap without removing the lock first. Inspect all WW caps for damage, cracks, or looseness. Wells with missing caps and locks should be reported the WI&M coordinator.

3.3.3 Down-hole Condition of the Screened or Open Interval (P)

The down-hole condition of the well screen or open interval can only be evaluated directly through the use of a down-hole video camera and the analysis of well performance information (e.g. hydraulic conductivity, pumping rates, specific yield, pumping duration), which is beyond the scope of this plan. For example, well screen deterioration caused by chemical or biological incrustation can result in substantial reduction in well yield (Driscoll, 1986). Depth measurements are the only direct method of measuring any change in the down-hole physical condition of a well, by comparing these measurements to a reference depth (see discussion below). Significant differences (>20% of the screened or open interval) between the measured depth and the reference depth may indicate:

- field measurement errors (e.g., wrong well, recording errors, or incorrect measurement reference point used) or errors in the weighted tape used to measure the depth (e.g., stretching, can't read tape increment, or weighted tapes shortened and the zero point changed)

- accumulations of sediments or other debris (incrustation by-products) in the bottom of the well, or
- obstructions exist in the well possibly caused by: 1) structural failure of the well casing or screen, 2) cave-in of the borehole wall within the open interval of the well, 3) instrumentation stuck in the well, or 4) snagging of measurement device due to down-hole orientation of casing or screen joints and the degree of vertical deviation of the well.

Many wells accumulate sediment at the bottom, which may plug the screened or open interval if the well is not properly developed. This sediment can affect the performance of the well and the quality of chemical analyses. The accumulation of sediments in the bottom of a well accounts for the differences between the reference depth (see discussion below) and the measure depth. Depth measurements are taken in accordance with Y-12 procedure Y71-50-EC-214, *Monitoring Well Inspection and Depth Measurement* (BWXT 2001).

All depth measurements are taken at the reference mark (designated reference point) located at either at the top of the innermost casing (riser casing, not the outer protective casing) recorded as feet below TOC, or from the top of the white PVC Well Wizard cap, recorded as feet below top TOWW. These are recorded to the nearest hundred of a foot. The WW cap extends the height of the riser casing (0.2 ft. to 1.0 ft depending on cap design, see Appendix A, Fig. 9) and must be standardized (corrected) to TOC. This is done by measuring the difference between the two reference points (Measurement Point Correction Factor), and subtracting this difference from the depth measurement from TOWW. The height of the sediment accumulation is calculated by subtracting the measured depth (standardized to TOC) from the reference depth ("well depth" on the checklist – which is standardized to TOC) and dividing by the length of the screened or open interval. If the height of sediment accumulation is 0.2 or greater, the interval is considered to be ≥20% filled, and a WMR is initiated requesting the well be rehabilitated and the interval cleared.

In previous WI&M plans, the constructed depth was used as the reference depth ("well depth" on the checklist, see Appendix B). The constructed depth is a calculated value based on well construction details provided in the Subsurface Database (BWXT 2003a). Because there are unexplained differences between the original well construction data and what is observed in the field, problems arose when using these constructed depth values in the calculation to determine the amount of sediment accumulation in a well. Discrepancies included: the measured depth being several feet deeper, or shallower, than the constructed depth over several measurements, but no other indication of sediment accumulation, obstruction and/or equipment in the well, or any other structural failure in the well.

These discrepancies were first noted in the 1991 *Well Inspection and Maintenance Plan* (MMES 1991) and in all subsequent published annual well inspection and maintenance reports (see examples BWXT 2002, BWXT 2003b, BWXT 2004b, and BWXT 2006a). The number of inspections revealed these discrepancies were substantial and consistent over several inspections. Starting with the CY 2003 well inspection event, an agreed upon reference depth (referred to as "reference tag depths"), based upon several past depth measurements (1994, 1997, and 2000), was used in lieu of the constructed depth (BWXT 2002). These reference tag depths (see Appendix D) will be utilized in all future well inspections and updated as necessary. As of this publication, Appendix D includes all reference tag depth for wells granted active or inactive status in the MOP (BWXT 2006b).

The WI&M coordinator provides additional well specific information to field personnel (Section 3.2) for wells that have obstructions or dedicated pumps in the well. For all 2-inch wells, WW pumps will need to remove prior to performing a depth measurement. Field personnel are required to note any other abnormalities, different than the information provided, or note any other reason that the measured depth differs significantly from the well depth. Field personnel are also required to indicate whether a depth measurement was hard or soft (an indicator of possible sediment buildup at the bottom of the well), and whether any mud was seen on the weighted tape.

Where the measured and reference tag depth differ substantially, the WI&M coordinator must determine if:

- a field measurement error occurred,
- the measurement did not pass the obstruction or dedicated instrumentation
- a new obstruction has occurred,
- sedimentation has occurred, or
- structural failure has occurred.

3.3.4 Well Identification (P)

Correct well identification is crucial for tracking all subsequent monitoring data obtained from the well. All monitoring wells must be accurately identified. All monitoring wells are required to have a well tag—a stainless steel or aluminum plate (Appendix A, Fig. 11) engraved, stamped, or etched with the well identification number. The well identification tag is attached to the riser casing, or to the outer protective casing, using a stainless steel cable (sized 1/16-in.) or aluminum ring threaded through a stainless steel pipe band that tightens to the casing. The well identification tag should be inspected to ensure that the well number is legible and correct. Tags with illegible or incorrect well numbers will be replaced. Field technicians must verify that the well identification tag corresponds to maps provided from Subsurface Database (BWXT 2003a). Additional well identification may also be present that includes: the well number engraved on the well cap, well number written on the well cap or casing, or the well number stenciled (painted) on the casing (Appendix A, Fig. 12). Stenciling is recommended, but the well identification tag is required for all wells.

3.3.5 Well Access (S)

Groundwater monitoring wells must be accessible in all weather conditions. Well access road conditions range from paved (asphalted) to gravel to a dirt/grass. Most well access areas inside the fenced section of Y-12 are paved and accessible. Well access roads comprised of gravel, dirt, or grass is common outside the fenced area of Y-12 and may or may not be maintained for use by another organization (security, power operations, or landfill operations). These roads are more susceptible to damage with heavy use, heavy equipment (mowers), and continual exposure and erosion overtime (washouts, ruts, gullies, and potholes). These roads require continual maintenance, from mowing (roads become quickly overgrown presenting visibility limitations for the driver) to road re-grading and re-gravelling.

Well access for all road types should be inspected to identify conditions that require maintenance (overgrown conditions, gullies, erosion of the road surface, or culvert damage) or preclude access to the wells (e.g., construction activities, impassible roads, new posted conditions, or fallen trees). Access restrictions and requirements not already provided by WI&M coordinator (Section 3.2) should be noted on the inspection checklist. Any new conditions or restrictions should be noted and communicated to the WI&M coordinator. Maintenance involves mowing, bush hogging, weedeating, and removing any obstacles blocking (construction fencing, fallen trees, equipment, storage material, jersey bouncers, and temporary buildings) the access road. Repairing and re-grading roads surfaces will be done on an as-needed basis and dependent upon well status and available resources. Maintenance may also involve removing barriers that block access to wells.

3.3.6 Concrete Pad (S)

Concrete pads are used to prevent infiltration of surface water and surface contamination through the annular space between the borehole and the casing. A surface pad (3 × 3 × 0.75 ft.) of concrete is emplaced (Appendix A, Fig. 13) around the outermost casing. Concrete pads are required for all active monitoring well, but for those wells installed prior to 1986 that may or may not have a pad, the WMR for emplacing concrete pads at the wells will be evaluated on a case-by-case basis.

The top of the concrete pad should be a minimum of 3-in. above ground level and sloped away from the well to prevent water from ponding around the well casing or protective surface casing. Inspection of the concrete pad will include identifying any damage, cracks, deterioration, and determining whether the top of the concrete pad is properly sloped. Maintenance may include patching cracks, patching damaged or deteriorated areas of the pad, excavating and replacing the pad, stabilizing the existing pad, or placing additional concrete to ensure that the pad is properly sloped.

3.3.7 Protective Posts (S)

Protective posts are required for all active monitoring wells to protect the exposed riser casing (portion above ground surface) from collision damage (e.g., mowing equipment, vehicular traffic, heavy equipment). Four posts are normally installed a minimum of 3 ft. deep (Appendix A, Fig. 14), at the corners of the concrete pad, and painted high-traffic yellow. Placement of the posts should protect the well from all potential traffic approaches (normally 4 ft. to 5 ft. apart). The height of the posts (a minimum of 3 ft. above ground surface) should protect the well from vehicular collision damage and allow work-over rigs and sampling vehicles to access the well casing. The posts should be inspected for physical damage or deterioration, paint degradation, and proper positioning. Maintenance will generally involve repainting, but damaged posts must be replaced and additional posts may be installed if conditions warrant.

3.4 RECORD-KEEPING AND REPORTING

The records generated by the Well Inspection and Maintenance Program include:

- well inspection checklists (annual and triennial),
- well maintenance requests (generated as needed), and
- plugging and abandonment requests (generated as needed).

These records have been published in annual Well Inspection and Maintenance reports (BWXT 2002, 2003b, 2004b, and 2006a) for the year in which they were generated. Following the CY 2003 well inspection event, this report is to be published on a triennial basis and will include: a well inspection/maintenance summary for each year's inspection, the checklists from the triennial well inspection event, and all well maintenance requests and P&A requests that were issued and completed since the last WI&M report.

A record copy of this WI&M plan will be kept on file by the GWPP and Y-12 Central Records. This plan will be reviewed on a triennial basis for obsolescence, and updated as needed to reflect current business practices of the WI&M program. The status designation of wells (active and inactive), as specified in the MOP, is not static and any changes to this status will be documented in addenda to the MOP.

Training records of field personnel to procedure Y71-50-EC-214, *Monitoring Well Inspection and Depth Measurement*, are maintained in Y-12 SAP business management database.

4.0 REFERENCES

BWXT Y-12, L.L.C. 2001. *Monitoring Well Inspection and Depth Measurement.* BWXT Y-12 Requirement, prepared by the Y-12 Environment, Safety, and Health Division (Y71-66-EC-214).

BWXT Y-12, L.L.C. 2002. *Results of Calendar Year 2000 Monitoring Well Inspection and Maintenance Program, Y-12 National Security Complex, Oak Ridge, Tennessee.* Prepared by the Y-12 Environment, Safety, and Health Division (Y/TS-1872).

BWXT Y-12, L.L.C. 2003a. *Updated Subsurface Data Base for Bear Creek Valley, Chestnut Ridge, and Parts of Bethel Valley on the U.S. Department of Energy Oak Ridge Reservation.* (Y/TS-881/R5).

BWXT Y-12, L.L.C. 2003b. *Results of Calendar Year 2001 Monitoring Well Inspection and Maintenance Program, Y-12 National Security Complex, Oak Ridge, Tennessee.* Prepared by the Y-12 Environment, Safety, and Health Division (Y/TS-1889).

BWXT Y-12, L.L.C. 2004a. *Groundwater Protection Program Management Plan for the U.S. Department of Energy Y-12 National Security Complex, Oak Ridge, Tennessee.* Prepared by Elvado Environmental LLC. (YSUB/01-006512/2/R1).

BWXT Y-12, L.L.C. 2004b. *Results of Calendar Year 2002 Monitoring Well Inspection and Maintenance Program, Y-12 National Security Complex, Oak Ridge, Tennessee.* Prepared by the Y-12 Environment, Safety, and Health Division (Y/TS-1993).

BWXT Y-12, L.L.C. 2006a. *Results of Calendar Year 2003 Monitoring Well Inspection and Maintenance Program, Y-12 National Security Complex, Oak Ridge, Tennessee.* Prepared by the Y-12 Environment, Safety, and Health Division (Y/TS-2011)

BWXT Y-12, L.L.C. 2006b. *Y-12 Groundwater Protection Program Monitoring Optimization Plan for Groundwater Monitoring Wells at the U.S. Department of Energy Y-12 National Security Complex, Oak Ridge, Tennessee.* Prepared by Elvado Environmental LLC (Y/TS-2031).

Driscoll, F.G. 1986. *Groundwater and Wells.* Second Edition. Johnson Division, St. Paul, Minnesota.

Lockheed Martin Energy Systems, Inc. 1996. *Monitoring Well Inspection and Maintenance Plan, Y-12 Plant, Oak Ridge, Tennessee (Revised).* Prepared by the Y-12 Environment, Safety, and Health Organization (Y/TS-1215).

Martin Marietta Energy Systems, Inc. 1994. *Monitor Well Inspection and Maintenance Plan, Y-12 Plant, Oak Ridge, Tennessee (Revised).* Prepared by the Y-12 Environment, Safety, and Health Organization (Y/TS-1215).

Martin Marietta Energy Systems, Inc. 1991. *Monitor Well Inspection and Maintenance Plan for the Department of Energy Y-12 Plant, Oak Ridge, Tennessee.* Prepared by HSW Environmental Consultants, Inc. (Y/SUB/01-YP507C/5).

Appendix A

APPENDIX A: FIGURES

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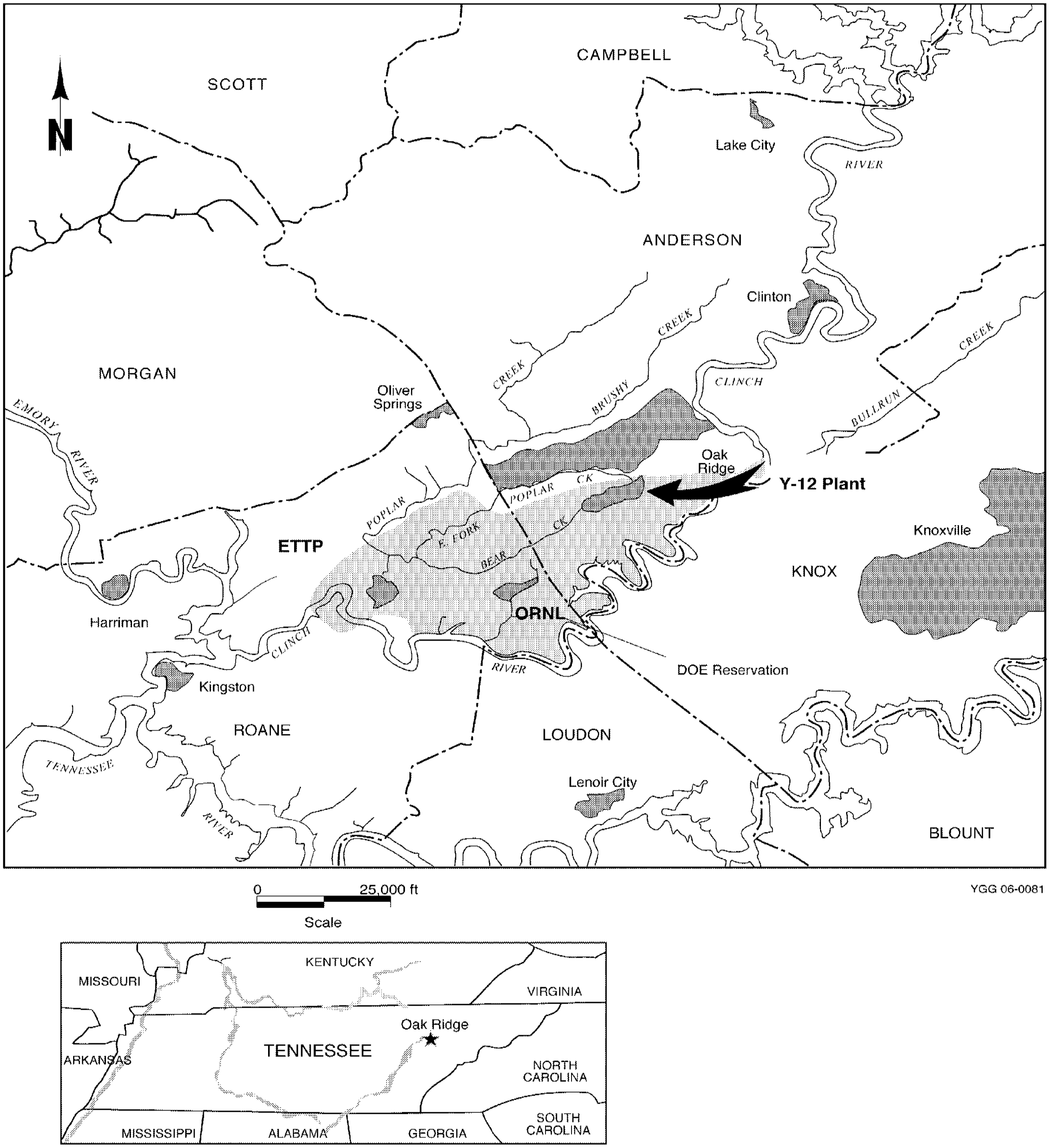


Fig. 1. Generalized location of the Y-12 National Security Complex.

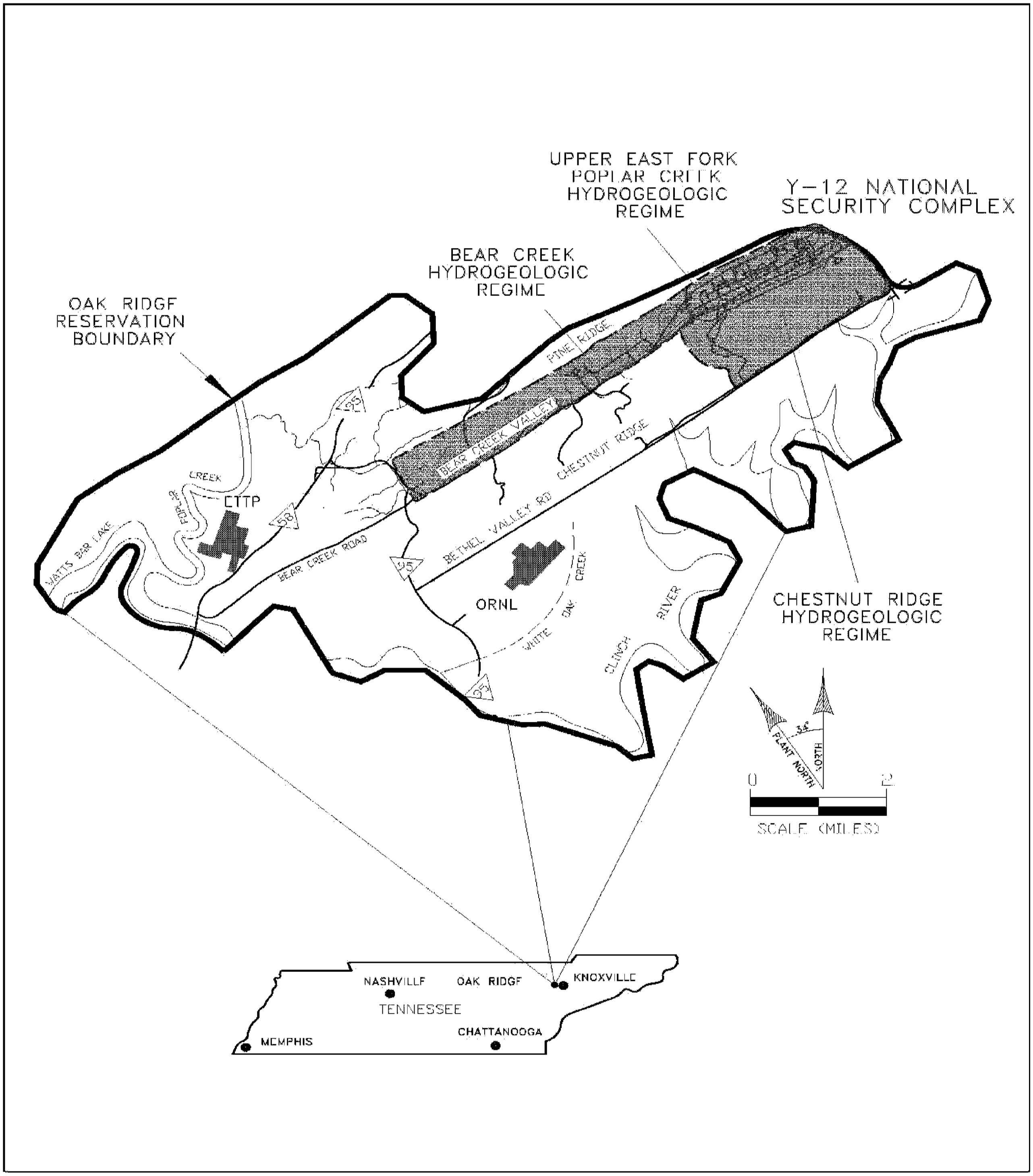


Fig. 2. Hydrogeologic regimes at the Y-12 National Security Complex.

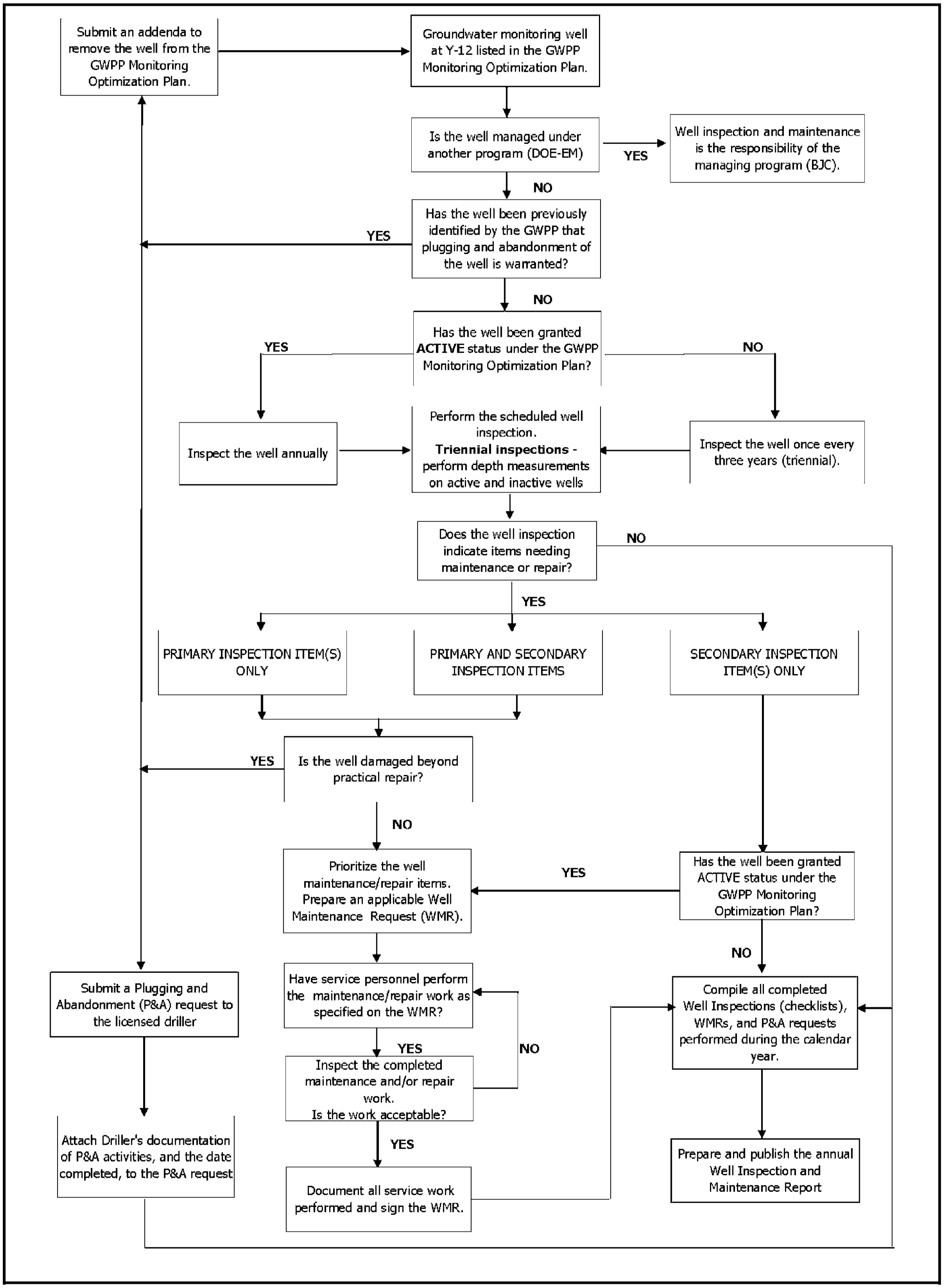
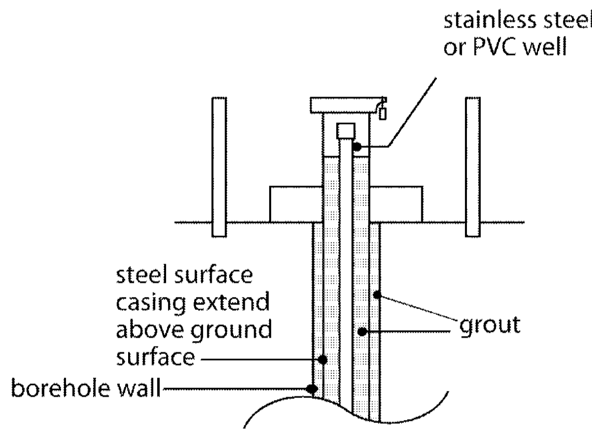
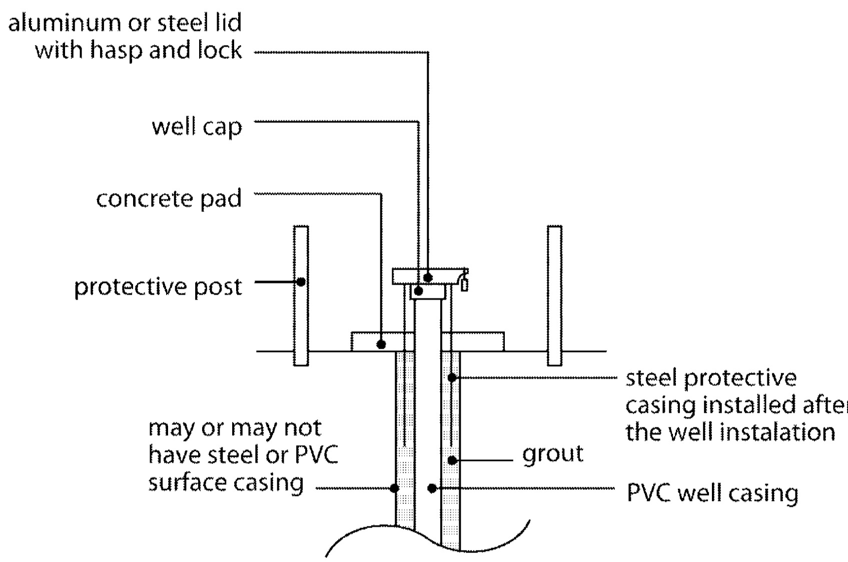


Fig. 3. Y-12 GWPP Monitoring Well Inspection and Maintenance Program.





Unconsolidated Zone

Note: Older generation PVC wells and PVC piezometers/drivepoint at Y-12 do not have a steel protecive casing

Not To Scale

YGG 06-0075R1

Fig. 4. Generalized schematic of outer protective surface casing for PVC and stainless steel wells in unconsolidated and bedrock zone.

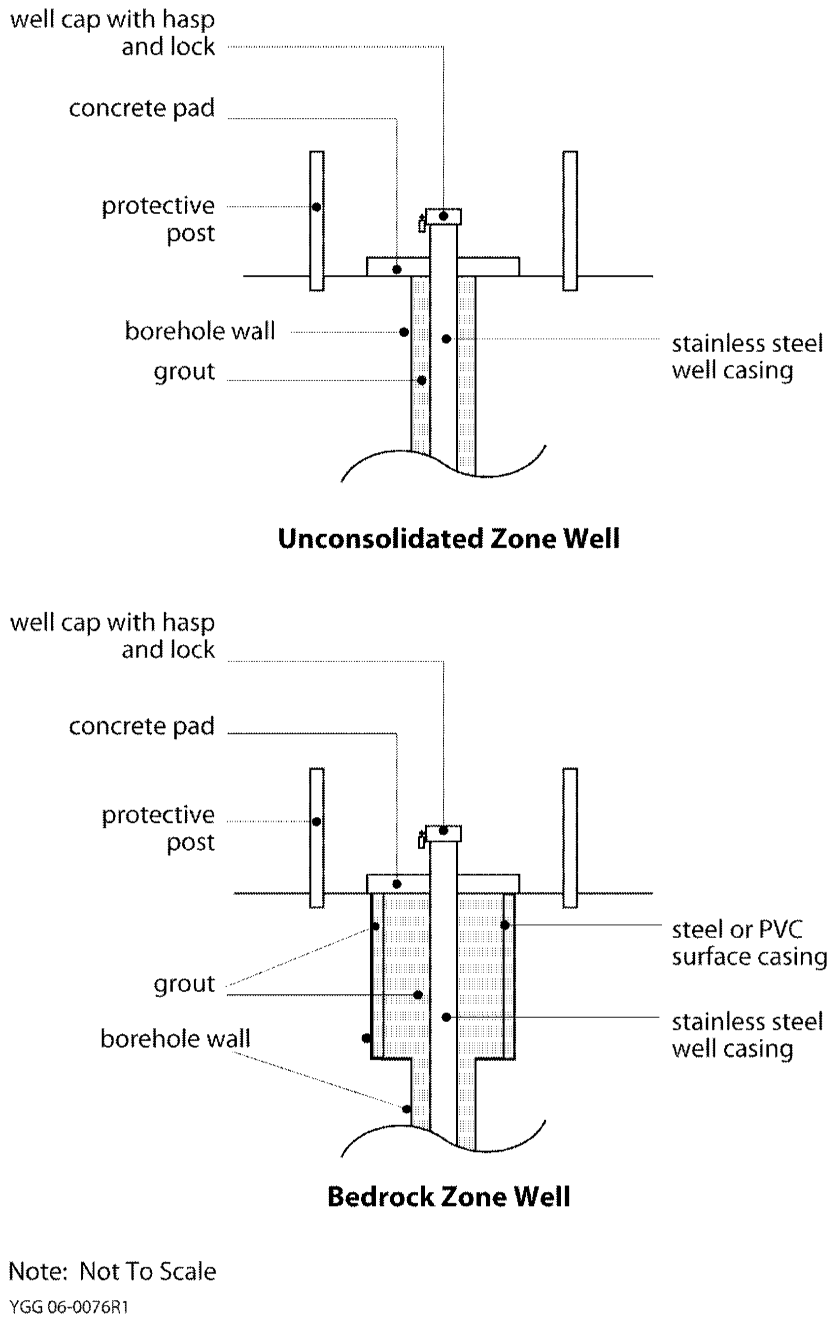


Fig. 5. Generalized schematic of stainless steel cased wells with screened intervals.

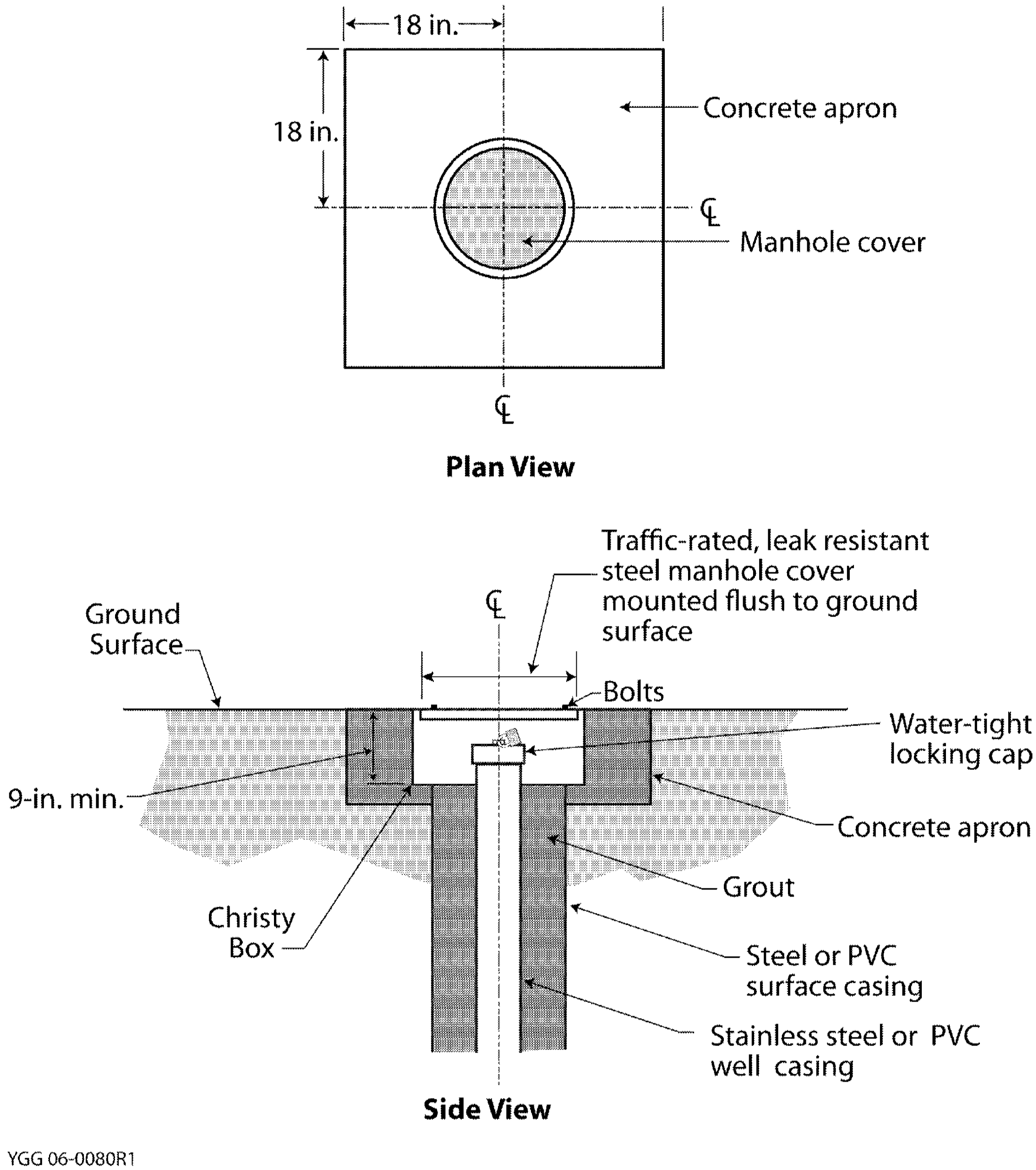


Fig. 6. Generalized schematic for wells completed with flush-mount manhole.

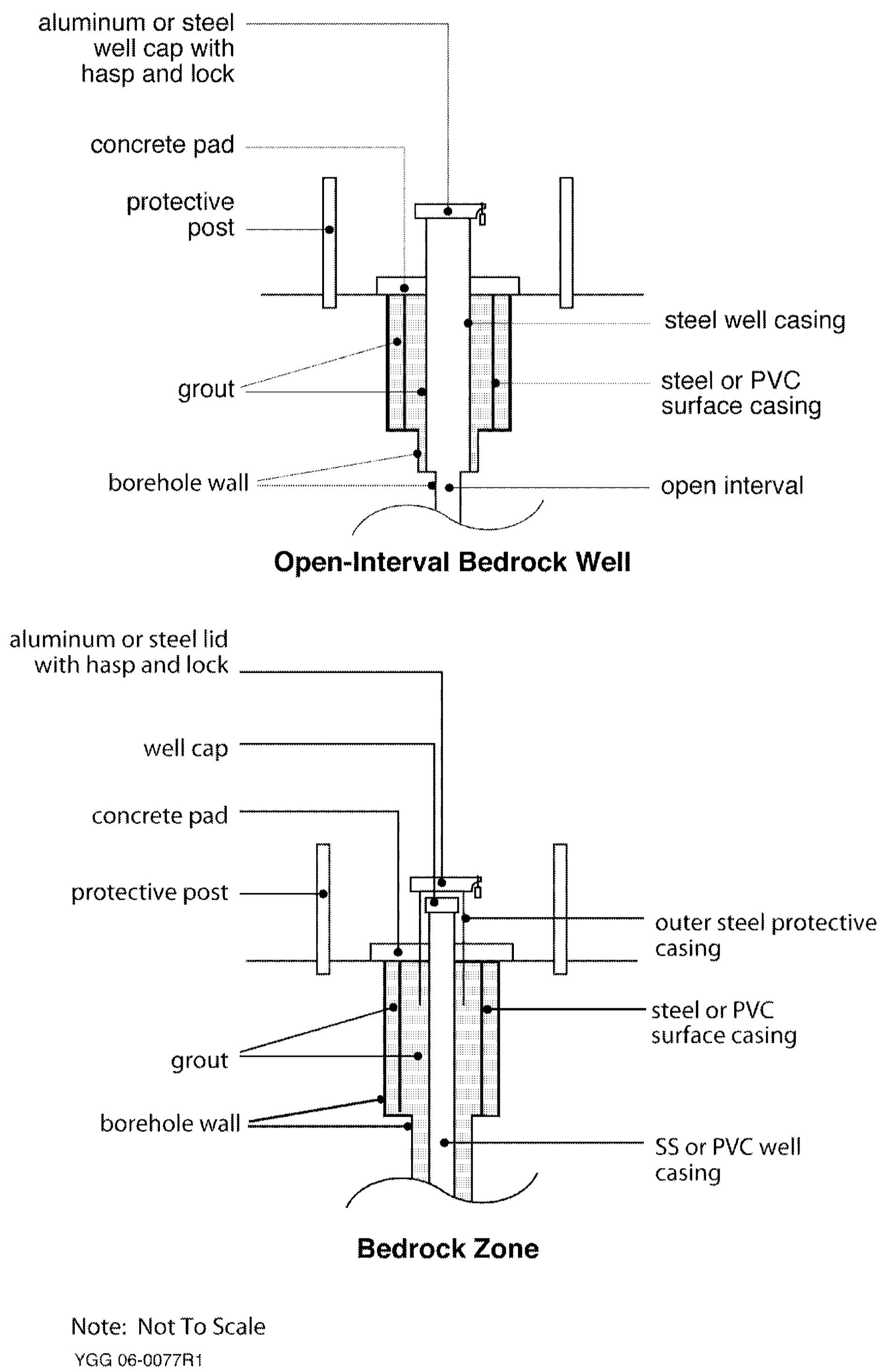


Fig. 7. Generalized schematic of steel cased wells with an open monitoring interval in bedrock.

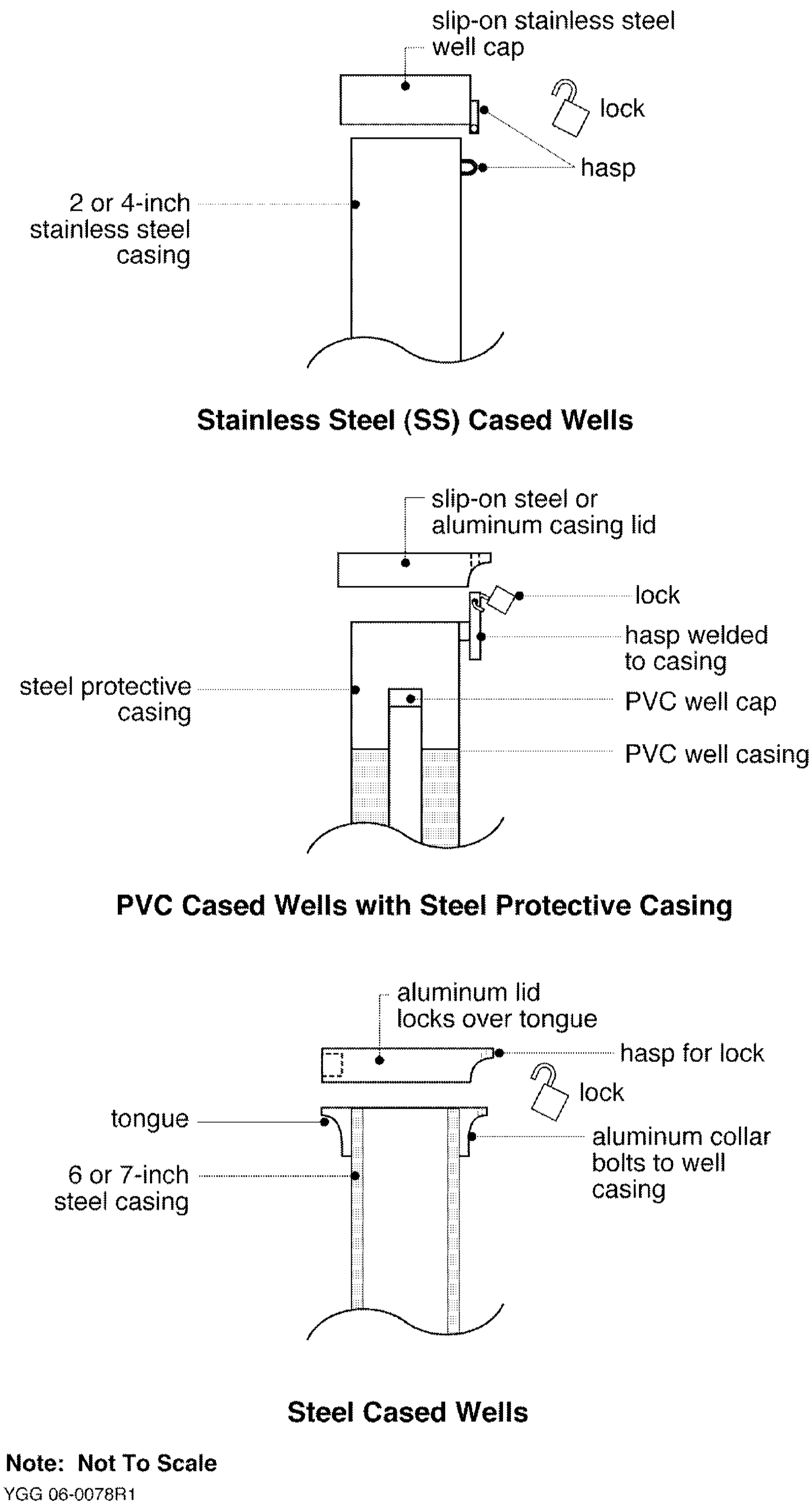


Fig. 8. Generalized schematics of typical well-head configurations with cap, hasp, and lock.

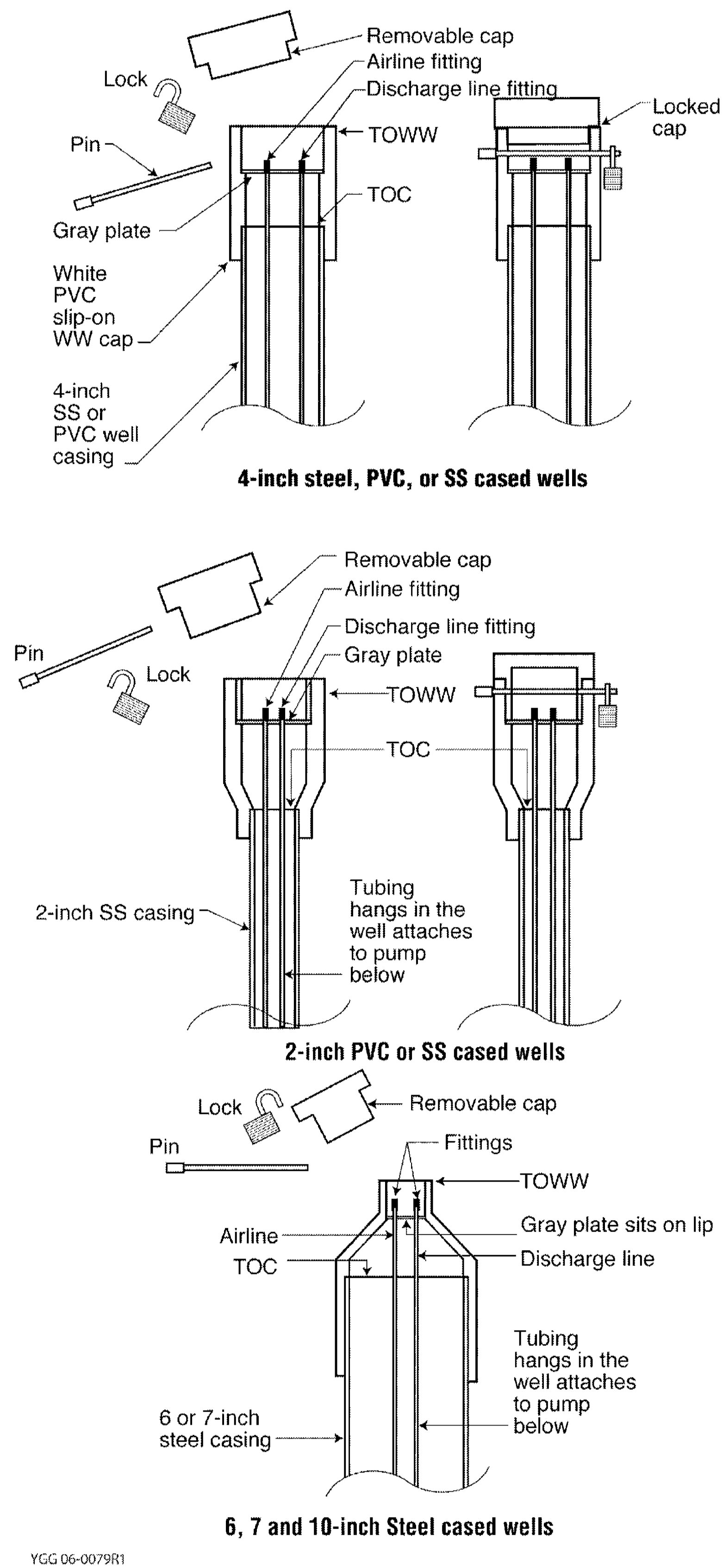


Fig. 9. Schematic of different configurations with Well Wizards.

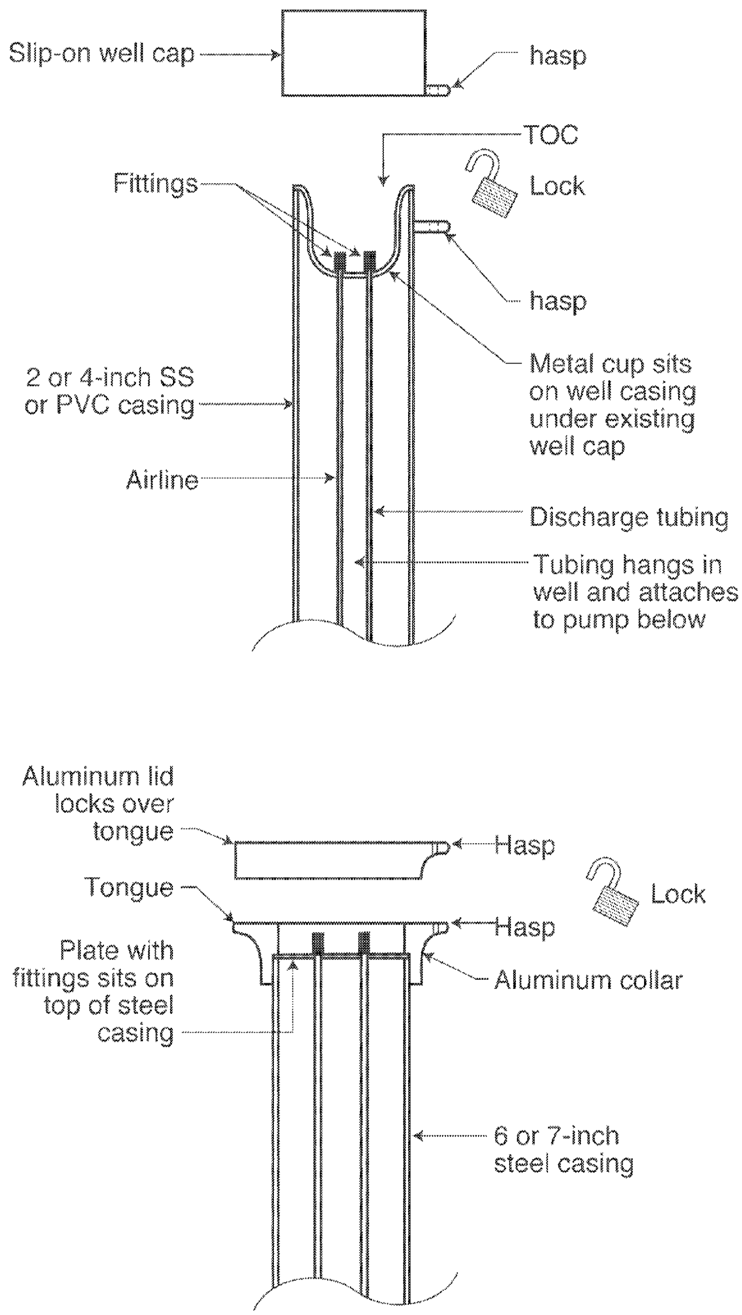


Fig. 10. Well Wizards with low clearance caps.

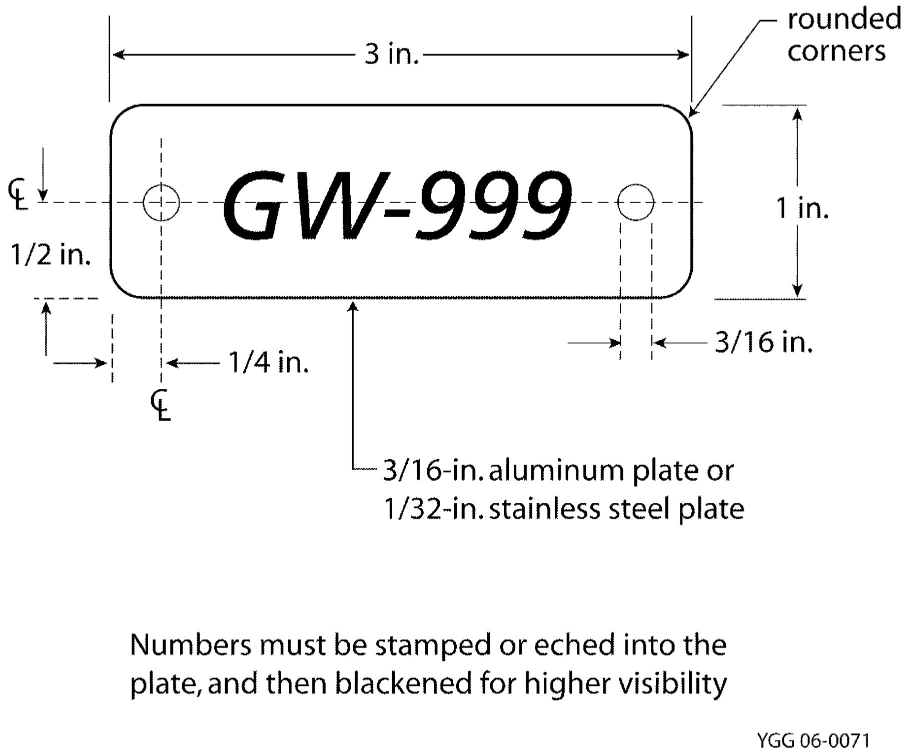


Fig. 11. Typical well identification tag.

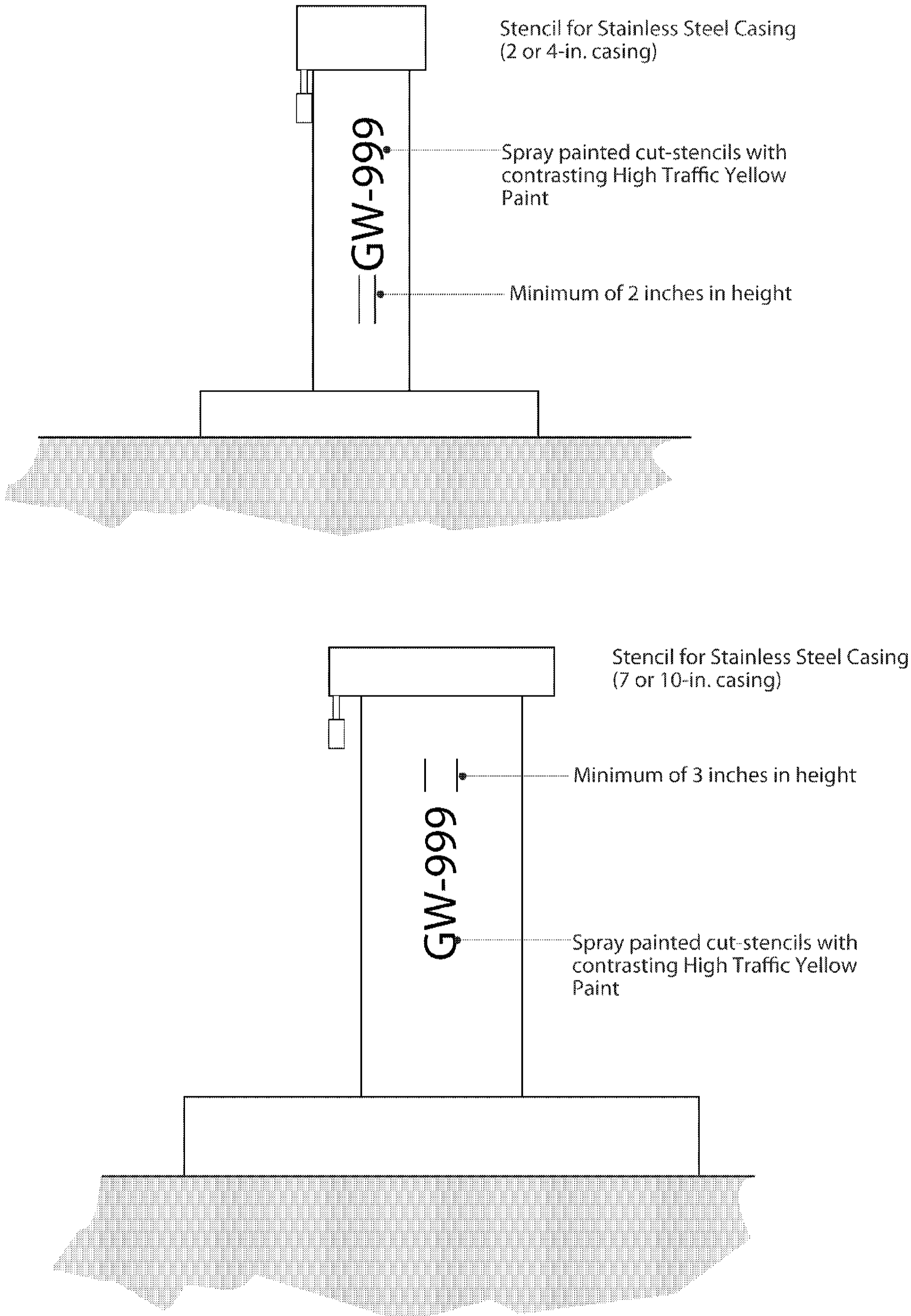


Fig. 12. Typical casing stencils.

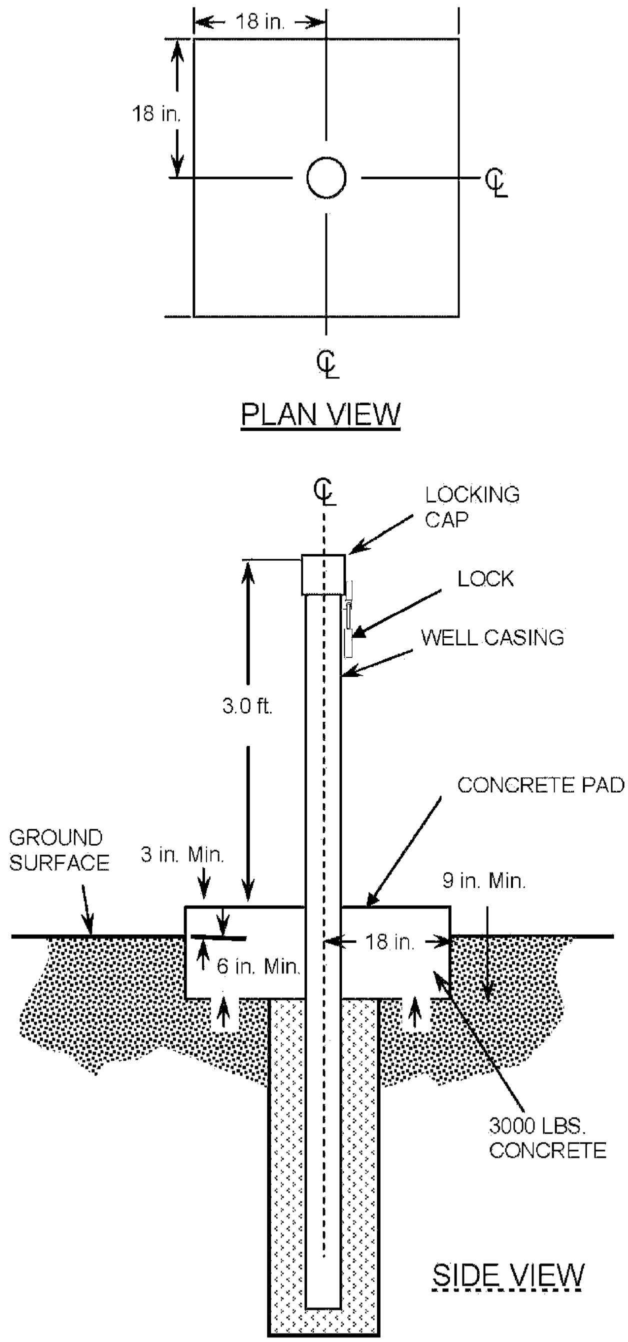


Fig. 13. Typical concrete pad.

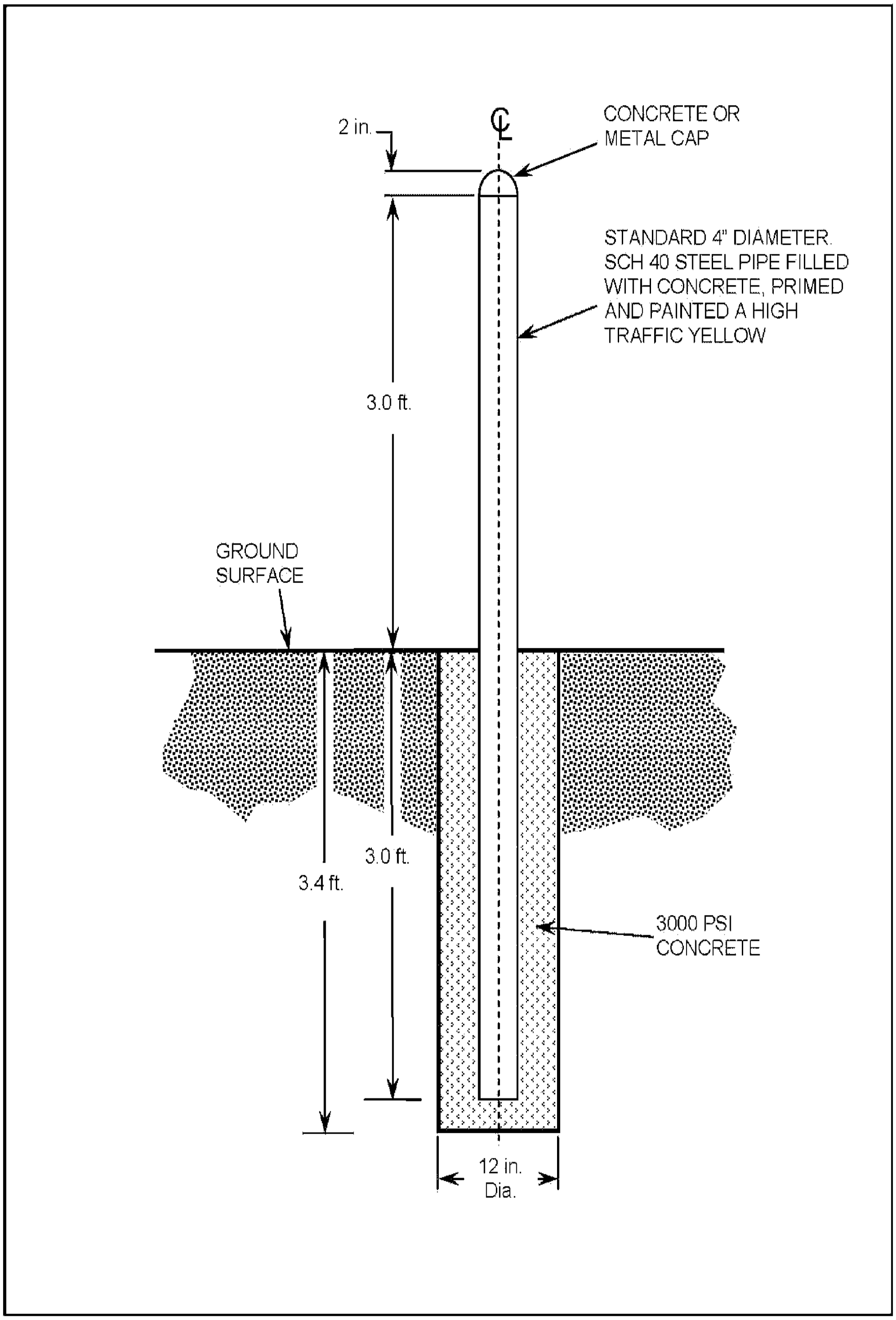


Fig. 14. Typical guard post.

Appendix B

APPENDIX B: WELL INSPECTION CHECKLIST FORMS

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Y-12 GWPP AWIC Rev. 10 (12/14/2006)

Y-12 PLANT GROUNDWATER PROTECTION PROGRAM
WELL INSPECTION CHECKLIST (**Annual Inspection**)
INSPECTION NO: __________

WELL INFORMATION

Well Number: ____________ Length of Screen or Open Interval (ft.): ____________
Site: ____________ Well Depth (ft.below TOC): ____________

PRIMARY INSPECTION ITEMS

INNER WELL CASING: ☐ Steel ☐ Stainless Steel ☐ PVC

	NO	YES	N/A
1. Is the inner or outer well casing, corroded, bent, dent, cracked, or broken?	☐	☐	☐
2. Has either well casing sustained vehicular damage?	☐	☐	☐
3. If warranted, is a weep located at the base of the outer protective casing?	☐	☐	☐
4. Is the inner or outer well casing loose (annular seal broken)?	☐	☐	☐
5. If flush-mounted, is the traffic cover, christy box, or annular seal damaged or excessively rusted?	☐	☐	☐
6. If flush-mounted, is the rubber gasket seal in good condition?	☐	☐	☐
WELL SECURITY:			
7. Does the outermost well casings have a lockable cap or lid?	☐	☐	☐
8. Does this cap fit snuggly over or inside the casing and can not be removed when locked?	☐	☐	☐
9. Is there a waterproof steel/brass lock present?	☐	☐	☐
10. Where applicable, are the hasps welded firmly to well cap and/or metal casing?	☐	☐	☐
11. If flush-mounted, is the traffic cover securely bolted to the christy box?	☐	☐	☐
12. If flush-mounted, is there a water tight cap; does it seal and is it lockable?	☐	☐	☐
WELL IDENTIFICATION:			
13. Is the well tag (SS or aluminum plate engraved with well number) attached to the outermost casing?	☐	☐	☐
14. Is the well number legible on the well tag?	☐	☐	☐
15. Is the well identification number correct (verify against map)?	☐	☐	☐
16. Is there secondary identification (stencil, stamped, handwritten, painted on casing or cap)?	☐	☐	☐
DOWN-HOLE CONDITION:			
17. Is dedicated sampling equipment present in the well?	☐	☐	☐
18. Is a reference point marked on the top of the casing (TOC) or top of Well Wizard cap (TOWW)?	☐	☐	☐

SECONDARY INSPECTION ITEMS

WELL ACCESS:	NO	YES	N/A
19. Does the access road require re-grading or additional gravel?	☐	☐	☐
20. Does the access road require weedeating or bushhogging?	☐	☐	☐
21. Do any restriction (locked gates, fallen trees, construction, RAD area, etc.) preclude access to well?	☐	☐	☐
Explain: ____________			
CONCRETE PAD:			
22. Is a concrete pad installed (active wells only)?	☐	☐	☐
23. Is the pad cracked or deteriorated?	☐	☐	☐
24. Does the pad sloped away from the casing or christy box to prevent water from ponding ?	☐	☐	☐
PROTECTIVE POSTS:			
25. Are the protective posts damaged?	☐	☐	☐
26. Are the protective posts positioned to prevent collision damage to well (< 6ft apart)?	☐	☐	☐
27. Are the protective posts of adequate height (3 ft)?	☐	☐	☐
28. Is the high-traffic yellow paint degraded?	☐	☐	☐

WELL MAINTENANCE REQUEST

Complete this section if at least one shaded box has a check mark:

☐ Primary Items ☐ Secondary Items Well Maintenance Request Number : ____________

COMMENTS

Inspection Date: ____________ Inspected By: ____________

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Y-12 GWPP TWIC Rev. 10 (12/14/2006)

Y-12 PLANT GROUNDWATER PROTECTION PROGRAM
WELL INSPECTION CHECKLIST (**Triennial Inspection**)
INSPECTION NO: __________

WELL INFORMATION

Well Number: ____________________ Length of Screen or Open Interval (ft.): __________
Site: ____________________ Well Depth (ft.below TOC): __________

PRIMARY INSPECTION ITEMS

INNER WELL CASING: ☐ Steel ☐ Stainless Steel ☐ PVC

	NO	YES	N/A
1. Is the inner or outer well casing, corroded, bent, dent, cracked, or broken?	☐	▒	☐
2. Has either well casing sustained vehicular damage?	☐	▒	☐
3. If warranted, is a weep located at the base of the outer protective casing?	▒	☐	☐
4. Is the inner or outer well casing loose (annular seal broken)?	☐	▒	☐
5. If flush-mounted, is the traffic cover, christy box, or annular seal damaged or excessively rusted?	☐	▒	☐
6. If flush-mounted, is the rubber gasket seal in good condition?	▒	☐	☐
WELL SECURITY:			
7. Does the outermost well casings have a lockable cap or lid?	▒	☐	☐
8. Does this cap fit snuggly over or inside the casing and can not be removed when locked?	▒	☐	☐
9. Is there a waterproof steel/brass lock present?	▒	☐	☐
10. Where applicable, are the hasps welded firmly to well cap and/or metal casing?	▒	☐	☐
11. If flush-mounted, is the traffic cover securely bolted to the christy box?	▒	☐	☐
12. If flush-mounted, is there a water tight cap; does it seal and is it lockable?	▒	☐	☐
WELL IDENTIFICATION:			
13. Is the well tag (SS or aluminum plate engraved with well number) attached to the outermost casing?	▒	☐	☐
14. Is the well number legible on the well tag?	▒	☐	☐
15. Is the well identification number correct (verify against map)?	▒	☐	☐
16. Is there secondary identification (stencil, stamped, handwritten, painted on casing or cap)?	▒	☐	☐
DOWN-HOLE CONDITION:			
17. Is dedicated sampling equipment present in the well?	☐	☐	☐
18. Is a reference point marked on the top of the casing (TOC) or top of Well Wizard cap (TOWW)?	▒	☐	☐
19. Measurement Point Correction Factor (MPCF) = TOWW - TOC	____________ ft.		
20. Measured depth of well from TOC or TOWW (please circle one):	____________ ft.		
21. Calculate: Well depth - Measured depth (corrected to TOC) / Screen or Open Interval Length	____________		
22. Is this value > 0.2 (20% of screen or open-hole interval filled with sediment)?	☐	▒	☐
23. Do any obstructions occur within the well?	☐	▒	☐
24. Is the bottom of the well (depth measurement) soft (i.e. mud on the tag line)?	☐	▒	☐

SECONDARY INSPECTION ITEMS

WELL ACCESS:	NO	YES	N/A
25. Does the access road require re-grading or additional gravel?	☐	▒	☐
26. Does the access road require weedeating or bushhogging?	☐	▒	☐
27. Do any restriction (locked gates, fallen trees, construction, RAD area, etc.) preclude access to well?	☐	▒	☐
Explain: ____________________			
CONCRETE PAD:			
28. Is a concrete pad installed (active wells only)?	▒	☐	☐
29. Is the pad cracked or deteriorated?	☐	▒	☐
30. Does the pad sloped away from the casing or christy box to prevent water from ponding ?	▒	☐	☐
PROTECTIVE POSTS:			
31. Are the protective posts damaged?	☐	▒	☐
32. Are the protective posts positioned to prevent collision damage to well (< 6ft apart)?	▒	☐	☐
33. Are the protective posts of adequate height (3 ft)?	▒	☐	☐
34. Is the high-traffic yellow paint degraded?	☐	▒	☐

WELL MAINTENANCE REQUEST

Complete this section if at least one shaded box has a check mark:
☐ Primary Items ☐ Secondary Items Well Maintenance Request Number : __________

COMMENTS

____
____
____

Inspection Date: ____________________ Inspected By: ____________________

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Appendix C

APPENDIX C:
WELL MAINTENANCE REQUEST FORM
PLUGGING AND ABANDONMENT REQUEST FORM

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Y-12 GWPP WMR form 05/15/06

Y-12 GROUNDWATER PROTECTION PROGRAM
WELL MAINTENANCE REQUEST (WMR)

WMR NUMBER: ____________________

WELL INSPECTION NO.: ____________________

WELL NUMBER:	LOCATION:
WELL INSPECTION DATE:	INSPECTED BY:

MAINTENANCE WORK REQUESTED :

- ☐ Build/Repair Concrete Pad
- ☐ Install/Paint Protective Posts
- ☐ Repair/Replace Hasp
- ☐ Remove/Replace Lock
- ☐ Well Re-development
- ☐ Repair/Replace Christy Box
- ☐ Replace gasket seals or bolts on Traffic Cover
- ☐ Replace Well Cap or Lid
- ☐ Extend or Repair Well Casing
- ☐ Install/Replace Well Identification Tag
- ☐ Well Access (weedeating, mowing, re-grading)
- ☐ Miscellaneous Labor (retrieval of items in well, weepholes, etc)
- ☐ Other (describe below)

DESCRIPTION OF WORK : ____________________

DATE WMR SUBMITTED:	JHA# :
MAINTENANCE PERFORMED BY (name and badge #):	
DATE WORK COMPLETED:	Service Notification or RFE# :

COMMENTS ON MAINTENANCE WORK PERFORMED: ____________________

WORK INSPECTED BY:	DATE INSPECTED:

INSPECTION COMMENTS: ____________________

APPROVED BY: ____________________ DATE: ____________________

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Y-12 GWPP P/A FORM 05-15-06

Y-12 GROUNDWATER PROTECTION PROGRAM
PLUGGING AND ABANDONMENT (P&A) REQUEST

P&A REQUEST NUMBER: ____________

WELL NUMBER:	SITE:
INSPECTION NUMBER:	INSPECTED BY:

REASON FOR PLUGGING AND ABANDONMENT:

- ☐ Well Casing Damage/Deterioration
- ☐ Annular Grout Deterioration
- ☐ Loss of Well Security
- ☐ Downhole Conditions
- ☐ Site Construction, Closure, or Operation

COMMENTS/EXPLANATION FOR P&A:

P&A REQUEST SUBMITTED BY:	DATE SUBMITTED:
CONTRACTOR PERFORMING P&A ACTIVITIES:	DATE COMPLETED:

P&A DOCUMENTATION ATTACHED ? YES ☐ NO ☐

APPROVED BY: ______________________ DATE: ______________
(GWPP MANAGER OR DESIGNEE)

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Appendix D

APPENDIX D:
REFERENCE TAG DEPTHS

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APPENDIX D — REFERENCE TAG DEPTHS

Well[1]	Regime[2]	Regulatory Program[3]	Reference Tag Depth[4]
1082	CR		55.00
1084	CR		148.60
1090	CR	BJC	98.02
53-1A	EF		22.00
54-2B	EF		26.15
55-1A	EF		19.22
55-1B	EF		38.70
55-1C	EF		76.60
55-2A	EF		13.98
55-2B	EF		27.69
55-2C	EF		76.00
55-3A	EF		14.25
55-3B	EF		37.98
55-3C	EF		77.43
55-6A	EF		12.77
56-1A	EF		18.95
56-1C	EF		73.45
56-2A	EF		15.03
56-2B	EF		38.63
56-2C	EF		77.03
56-3A	EF		17.92
56-3B	EF		30.85
56-3C	EF		55.35
56-4A	EF		12.60
56-6A	EF		20.97
56-7A	EF		21.13
56-8A	EF		25.44
58-2A	EF		9.78
59-1A	EF		13.10
59-1B	EF		36.80
59-1C	EF		75.46
60-1A	EF		23.10
60-1B	EF		29.10
CH-143	CR		58.27
CH-157	CR		538.73
CH-185	CR		839.95
CH-189	CR		765.43
GW-001	BC		27.56
GW-006	BC		51.08
GW-008	BC	BJC	26.69
GW-010	BC	BJC	16.50
GW-011	BC		43.22
GW-012	BC	BJC	19.20
GW-013	BC		7.06
GW-014	BC	BJC	14.50
GW-015	BC		11.69
GW-016	BC		18.88
GW-017	BC		65.35
GW-018	BC		21.71
GW-040	BC		33.73
GW-041	BC		42.48
GW-042	BC		32.31
GW-045	BC		17.66
GW-046	BC	BJC	23.85

[1] **Wells** = An active or inactive well in accordance with the 2006 GWPP Monitoring Optimization Plan
[2] **Regime** = Upper East Fork Poplar Creek (EF), Bear Creek (BC) and Chestnut Ridge (CR) Hydrogeologic Regimes at Y-12 National Security Complex (Y-12)
[3] **Regulatory Program** = well is monitored for regulatory purposes by another program (BJC = Bechtel Jacobs LLC, Landfills = Energy Solutions LLC)
[4] **Reference Tag Depths** = were determined from measured depths during the 1994, 1997, and 2000 well inspections and were evaluated against the calculated constructed depth for each well.

APPENDIX D — REFERENCE TAG DEPTHS

Well[1]	Regime[2]	Regulatory Program[3]	Reference Tag Depth[4]
GW-047	BC		26.97
GW-052	BC		22.04
GW-053	BC		35.13
GW-054	BC		40.75
GW-055	BC		22.89
GW-056	BC		59.21
GW-057	BC		25.17
GW-058	BC		48.90
GW-059	BC		27.65
GW-061	BC		28.09
GW-062	BC		54.13
GW-064	BC		55.07
GW-065	BC		36.89
GW-066	BC		59.24
GW-068	BC		86.10
GW-069	BC	BJC	101.96
GW-070	BC		142.13
GW-071	BC	BJC	218.40
GW-072	BC		101.99
GW-073	BC		81.44
GW-074	BC		208.21
GW-075	BC	BJC	205.59
GW-077	BC	BJC	104.10
GW-078	BC	BJC	23.40
GW-079	BC	BJC	64.70
GW-080	BC	BJC	33.00
GW-081	BC		20.98
GW-082	BC	BJC	38.45
GW-083	BC		33.14
GW-084	BC		29.92
GW-085	BC		62.34
GW-086	BC		33.01
GW-089	BC		27.97
GW-090	BC		18.81
GW-091	BC		19.30
GW-094	BC		119.21
GW-095	BC		157.03
GW-096	BC		56.38
GW-097	BC		23.86
GW-097A	BC		24.15
GW-098	BC		105.65
GW-100	BC		17.87
GW-101	BC	BJC	19.18
GW-105	EF		19.40
GW-106	EF		74.10
GW-107	EF		16.30
GW-108	EF	BJC	58.30
GW-109	EF	BJC	125.45
GW-115	BC		54.49
GW-117	BC		533.06
GW-118	BC		578.02
GW-119	BC		512.99
GW-120	BC		184.19
GW-121	BC		607.68

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APPENDIX D — REFERENCE TAG DEPTHS

Well[1]	Regime[2]	Regulatory Program[3]	Reference Tag Depth[4]
GW-122	BC		145.28
GW-123	BC		574.79
GW-124	BC		153.44
GW-125	BC		553.68
GW-126	BC		159.18
GW-127	BC	BJC	26.52
GW-131	EF		1,099.40
GW-132	EF		762.42
GW-133	BC		602.26
GW-134	BC		845.13
GW-135	BC		1,277.38
GW-141	CR	Landfills	158.81
GW-142	CR		298.20
GW-143	CR	BJC	252.70
GW-144	CR	BJC	194.34
GW-145	CR	BJC	113.49
GW-146	CR		217.01
GW-147	CR		72.82
GW-148	EF		13.93
GW-149	EF		50.35
GW-150	EF		14.75
GW-151	EF	BJC	99.63
GW-152	EF		20.76
GW-153	EF		60.84
GW-154	EF	BJC	13.35
GW-156	CR	BJC	157.65
GW-158	CR		442.60
GW-159	CR	BJC	155.87
GW-160	CR		230.52
GW-161	CR	BJC	402.88
GW-162	BC		128.50
GW-163	BC		227.13
GW-164	BC		406.49
GW-165	CR		309.37
GW-166	CR		381.40
GW-167	EF		32.81
GW-168	EF		138.13
GW-169	EF	BJC	36.23
GW-170	EF	BJC	156.16
GW-171	EF	BJC	32.64
GW-172	EF	BJC	137.50
GW-173	CR		167.34
GW-174	CR		151.94
GW-175	CR	BJC	169.49
GW-176	CR		147.33
GW-177	CR	BJC	150.69
GW-178	CR		134.68
GW-179	CR		122.50
GW-180	CR		146.08
GW-181	CR		169.45
GW-183	EF		33.30
GW-184	CR		131.41
GW-185	CR		470.88
GW-186	CR		172.02

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APPENDIX D — REFERENCE TAG DEPTHS

Well[1]	Regime[2]	Regulatory Program[3]	Reference Tag Depth[4]
GW-187	CR		163.67
GW-188	CR		73.15
GW-189	CR		206.56
GW-190	EF		29.84
GW-191	EF		65.09
GW-192	EF		21.58
GW-193	EF	BJC	21.17
GW-194	EF		15.88
GW-195	EF		24.92
GW-196	EF		28.67
GW-197	EF		19.67
GW-198	EF		29.57
GW-199	EF		25.92
GW-200	EF		59.96
GW-202	EF		22.59
GW-203	CR	BJC	157.61
GW-204	EF		20.23
GW-205	CR	BJC	165.13
GW-206	EF		17.12
GW-207	EF		114.73
GW-208	EF		416.62
GW-217	CR	Landfills	179.13
GW-218	EF		30.64
GW-219	EF	BJC	15.59
GW-220	EF	BJC	49.00
GW-221	CR	BJC	159.34
GW-222	EF		28.55
GW-223	EF	BJC	93.57
GW-224	CR		126.99
GW-225	BC		203.30
GW-226	BC		58.47
GW-227	BC		42.64
GW-228	BC		93.45
GW-229	BC		51.45
GW-230	EF	BJC	409.48
GW-231	CR	BJC	37.70
GW-232	EF	BJC	412.88
GW-236	BC		21.14
GW-237	BC		17.26
GW-239	EF		436.17
GW-240	EF		32.55
GW-241	CR		98.23
GW-242	BC		20.18
GW-243	BC	BJC	76.30
GW-244	BC	BJC	77.30
GW-245	BC	BJC	73.87
GW-246	BC	BJC	76.50
GW-247	BC	BJC	76.50
GW-248	BC		65.21
GW-249	BC		37.85
GW-250	BC		64.83
GW-251	EF		50.04
GW-252	EF		51.11
GW-253	EF	R / BJC	50.51

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APPENDIX D — REFERENCE TAG DEPTHS

Well[1]	Regime[2]	Regulatory Program[3]	Reference Tag Depth[4]
GW-255	EF		84.49
GW-257	BC	BJC	36.63
GW-258	BC		52.86
GW-259	BC		35.74
GW-261	EF		26.82
GW-262	EF		72.19
GW-263	EF		33.96
GW-264	EF		74.25
GW-265	EF		25.68
GW-268	EF		36.22
GW-269	EF		33.50
GW-270	EF		21.50
GW-271	EF		59.33
GW-272	EF		19.16
GW-273	EF		35.00
GW-274	EF	BJC	36.12
GW-275	EF	BJC	68.47
GW-276	BC	BJC	21.34
GW-277	BC		80.63
GW-281	EF	BJC	14.85
GW-282	EF		13.23
GW-283	EF		21.10
GW-284	EF		18.04
GW-285	EF		20.51
GW-286	BC		34.78
GW-287	BC		15.19
GW-288	BC		62.70
GW-289	BC	BJC	43.14
GW-290	BC		38.18
GW-291	BC	BJC	19.92
GW-292	CR	BJC	187.59
GW-293	CR	BJC	216.40
GW-294	CR	BJC	130.76
GW-296	CR	BJC	148.16
GW-298	CR	BJC	189.36
GW-299	CR		169.23
GW-300	CR		149.24
GW-301	CR	BJC	165.23
GW-302	CR	BJC	138.23
GW-303	CR		322.10
GW-304	CR		167.78
GW-305	CR	Landfills	181.06
GW-306	BC		60.66
GW-307	BC		43.60
GW-308	BC		40.61
GW-309	BC		40.06
GW-310	BC		30.47
GW-311	BC		43.64
GW-312	BC		42.10
GW-313	BC		121.40
GW-314	BC		118.15
GW-315	BC		105.98
GW-316	BC		81.64
GW-317	BC		133.33

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APPENDIX D — REFERENCE TAG DEPTHS

Well[1]	Regime[2]	Regulatory Program[3]	Reference Tag Depth[4]
GW-318	CR		82.62
GW-319	CR		26.21
GW-322	CR		191.99
GW-323	BC		109.59
GW-324	BC		81.80
GW-325	BC		19.87
GW-331	EF		32.60
GW-332	EF		27.07
GW-333	EF		27.46
GW-334	EF		29.72
GW-335	EF		17.29
GW-336	EF		23.93
GW-337	EF		25.33
GW-338	EF		20.20
GW-339	CR	BJC	116.92
GW-342	BC		72.28
GW-343	BC		189.70
GW-344	BC		317.92
GW-345	BC		29.16
GW-346	BC		68.13
GW-347	BC		30.52
GW-348	BC		83.33
GW-349	EF		27.81
GW-350	EF		46.85
GW-363	BC	BJC	77.27
GW-364	BC		62.86
GW-365	BC		152.49
GW-366	BC		104.43
GW-367	BC		153.48
GW-368	BC		247.46
GW-369	BC		150.30
GW-370	BC		35.44
GW-371	BC		127.56
GW-372	BC		54.24
GW-373	BC		159.06
GW-374	BC		152.43
GW-375	BC		163.33
GW-376	BC		221.92
GW-380	EF	BJC	15.80
GW-381	EF		61.01
GW-382	EF	BJC	173.20
GW-383	EF		26.54
GW-384	EF		58.21
GW-385	EF		180.32
GW-505	EF		16.80
GW-508	EF		15.11
GW-511	CR		156.00
GW-512	CR		64.28
GW-513	CR		127.53
GW-514	CR	BJC	197.13
GW-520	BC		82.76
GW-521	CR	BJC	136.70
GW-522	CR	Landfills	197.10
GW-526	BC	BJC	123.80

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APPENDIX D — REFERENCE TAG DEPTHS

Well[1]	Regime[2]	Regulatory Program[3]	Reference Tag Depth[4]
GW-531	BC		41.28
GW-532	BC		31.71
GW-533	BC		32.70
GW-534	BC		60.20
GW-535	BC		27.36
GW-537	BC		27.35
GW-538	BC		45.33
GW-539	CR		158.76
GW-540	CR	Landfills	173.83
GW-541	CR		106.10
GW-542	CR	Landfills	79.09
GW-543	CR	Landfills	96.24
GW-544	CR	Landfills	111.80
GW-546	CR		86.96
GW-557	CR	BJC	136.07
GW-558	CR		77.60
GW-559	CR		170.23
GW-560	CR	Landfills	82.90
GW-562	CR	BJC	61.24
GW-563	CR		97.63
GW-564	CR	Landfills	78.74
GW-567	CR		81.89
GW-569	CR		113.14
GW-576	CR		70.10
GW-601	BC		358.61
GW-602	BC		211.27
GW-603	EF		76.78
GW-604	EF		114.28
GW-605	EF	BJC	42.00
GW-606	EF	BJC	174.36
GW-608	CR	BJC	219.80
GW-609	CR	BJC	268.80
GW-610	CR		120.21
GW-611	CR		120.26
GW-612	CR		256.28
GW-613	BC		45.08
GW-614	BC		93.07
GW-615	BC	BJC	246.84
GW-616	BC		270.59
GW-617	EF		20.69
GW-618	EF	BJC	38.30
GW-619	EF		43.63
GW-620	EF		77.91
GW-621	BC		42.52
GW-622	BC		22.05
GW-623	BC		277.93
GW-624	BC		30.60
GW-625	BC		284.83
GW-626	BC		80.92
GW-627	BC		270.96
GW-628	BC		290.70
GW-629	BC		314.59
GW-630	BC		30.92
GW-631	EF		15.36

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APPENDIX D — REFERENCE TAG DEPTHS

Well[1]	Regime[2]	Regulatory Program[3]	Reference Tag Depth[4]
GW-633	EF		15.15
GW-634	EF		14.94
GW-636	BC		120.63
GW-637	BC		30.87
GW-638	BC		15.48
GW-639	BC	BJC	129.64
GW-640	BC		49.88
GW-641	BC		26.32
GW-642	BC		39.90
GW-643	BC		31.48
GW-645	BC		83.42
GW-646	BC		78.04
GW-647	BC		91.91
GW-648	BC		82.47
GW-649	BC		23.49
GW-651	BC		54.50
GW-652	BC		33.69
GW-653	BC		41.53
GW-654	BC		19.14
GW-655	BC		67.26
GW-656	EF		20.60
GW-657	EF		15.03
GW-658	EF	BJC	20.64
GW-659	EF		16.10
GW-673	CR		116.39
GW-674	CR		16.84
GW-676	CR		20.35
GW-677	CR		160.44
GW-678	CR		133.08
GW-679	CR		134.28
GW-680	CR		122.24
GW-681	CR		172.28
GW-682	CR		161.30
GW-683	BC	BJC	199.83
GW-684	BC	BJC	132.21
GW-685	BC		141.83
GW-686	EF		16.23
GW-688	EF		54.89
GW-690	EF		53.25
GW-691	EF		20.39
GW-692	EF		53.05
GW-693	EF		22.93
GW-694	BC		207.27
GW-695	BC		65.28
GW-696	EF		31.70
GW-697	EF		20.32
GW-698	EF		74.88
GW-699	EF		16.33
GW-700	EF		33.19
GW-701	EF		27.82
GW-702	EF		22.64
GW-703	BC		185.29
GW-704	BC	BJC	258.65
GW-705	BC		312.76

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Well[1]	Regime[2]	Regulatory Program[3]	Reference Tag Depth[4]
GW-706	BC	BJC	185.79
GW-709	CR	Landfills	83.52
GW-710	BC		750.73
GW-711	BC		668.57
GW-712	BC	BJC	460.53
GW-713	BC	BJC	318.39
GW-714	BC	BJC	146.90
GW-715	BC		45.96
GW-722	EF	BJC	642.68
GW-723	BC		447.24
GW-724	BC		293.60
GW-725	BC		145.42
GW-726	BC		602.62
GW-727	BC		1,002.77
GW-729	BC		1,363.24
GW-730	BC		1,428.25
GW-731	CR	BJC	178.53
GW-732	CR	BJC	192.84
GW-733	EF	BJC	259.93
GW-734	EF		60.32
GW-735	EF		81.81
GW-736	BC		104.00
GW-737	BC		92.03
GW-738	BC		91.78
GW-739	BC		322.88
GW-740	BC		192.67
GW-742	CR		422.03
GW-743	CR		162.56
GW-744	EF		69.28
GW-745	EF		35.25
GW-746	EF		17.14
GW-747	EF		82.33
GW-748	EF		29.80
GW-750	EF		75.49
GW-751	EF		63.33
GW-752	EF		18.80
GW-753	EF		73.76
GW-754	EF		27.19
GW-755	EF		63.17
GW-756	EF		18.95
GW-757	CR	Landfills	168.54
GW-758	EF		52.04
GW-759	EF		32.56
GW-760	EF		63.30
GW-761	EF		18.51
GW-762	EF	BJC	62.04
GW-763	EF		20.41
GW-764	EF		68.14
GW-765	EF		35.05
GW-766	EF		48.38
GW-767	EF		21.44
GW-768	EF		67.63
GW-769	EF		62.73
GW-770	EF		21.68

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Well[1]	Regime[2]	Regulatory Program[3]	Reference Tag Depth[4]
GW-773	EF		61.66
GW-774	EF		28.87
GW-775	EF		55.98
GW-776	EF		21.92
GW-777	EF		61.52
GW-778	EF		23.55
GW-779	EF		65.35
GW-781	EF		71.07
GW-782	EF		38.23
GW-783	EF		17.98
GW-790	BC		1,042.32
GW-791	EF		72.45
GW-792	EF		31.99
GW-794	BC		42.43
GW-795	BC		22.61
GW-796	CR	BJC/Landfills	139.82
GW-797	CR	Landfills	135.71
GW-798	CR	Landfills	134.00
GW-799	CR	BJC/Landfills	97.58
GW-800	BC		32.86
GW-801	CR	BJC/Landfills	190.92
GW-802	EF	BJC	25.42
GW-803	EF		27.76
GW-804	EF		27.79
GW-811	BC		67.77
GW-812	BC		48.26
GW-813	BC		28.05
GW-814	BC		26.28
GW-815	BC		23.84
GW-816	EF		17.99
GW-819	EF		16.44
GW-820	EF		17.18
GW-827	CR	Landfills	137.22
GW-828	BC		169.36
GW-829	BC		118.68
GW-831	CR	BJC	198.06
GW-832	EF	BJC	10.36
GW-834	BC		16.60
GW-835	BC	BJC	19.20
GW-836	BC		27.57
GW-841	CR	BJC	10.30
GW-842	CR	BJC	28.00
GW-843	CR	BJC	69.80
GW-844	CR		180.10
GW-845	EF	BJC	440.06

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